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# ***JPRS Report***

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# Science & Technology

## Central Eurasia: Electronics & Electrical Engineering

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### Averaged Characteristics of Acoustic Fields in Oceanic Waveguides

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in Russian Vol 38 No 4, Jul-Aug 92 (manuscript  
received 31 Jan 92) pp 601-608

[Article by V.V. Borodin, V.A. Zhuravlev, I.K. Kobozev, and Yu.A. Kvartsov, Small Specialized Enterprise "Trot" and Institute of Acoustics imeni N.N. Andreyev at Russian Academy of Sciences; UDC 534.21]

[Abstract] A simple method of describing the acoustic wave field in oceanic waveguides by its average characteristics which include those of the interference patterns is outlined, without concern about the necessary conditions for a sufficiently accurate prior evaluation of the fine interference structure. The basic step in this method is smoothing both the fine structure of acoustic interference, which also includes the sound attenuation by absorption pattern, and the waveguide nonhomogeneity. The space averaging interval must obviously be neither smaller than the space period of that fine structure nor too large as, say, the entire ocean breadth. Most expedient will obviously be averaging over either the space period of intermodal beats or the topographic profile pitch of the ocean floor. The averaging process is demonstrated analytically for an irregular sound channel with a monochromatic sound source on the channel surface at the point  $r=0, z=z_0$ , the acoustic pressure field in such a channel being represented as the sum of independent adiabatic modes in the approximation of axial symmetry of the sound channel with respect to the vertical  $z$ -axis passing through the point source of sound. A regular waveguide is treated as a simple special case and a Pekeris waveguide is used as the reference for extension to the general case of an irregular one. The average sound intensity at some distance from the source is shown to be proportional to the effective number of modes propagating through that distance and to be subject to the three-halves power law. At large distances from the source the phases of modes can be regarded as independent random quantities uniformly distributed over the entire  $0,2\pi$  interval. When the number of propagating modes is large and particularly so near the source, then the dependence of the sound intensity on the distance from the source is described as a stochastic relation. In this case the probability distribution of sound intensity is an exponential one and the field amplitude has a Rayleigh probability distribution, the dispersion of the field amplitude squared being then identically equal to the mean sound intensity and the phase differences between modes becoming quickly randomized. In this case, therefore, the acoustic pressure field is like one subject to Gaussian statistics. When the number of modes is small (4, 3, 2) and particularly so far from the source, then the dependence of the sound intensity on the distance from the source is preferably described as a deterministic relation. In this case the field amplitude distribution, far from a Rayleigh distribution, features less or more pronounced peaks. From these basic relations are derived analytical expressions

for both horizontal and vertical field-correlation radii, the frequency field-correlation "radius", and the numerical density of phase front dislocations (discontinuities at singular zero-amplitude points on field lines in a multimode waveguide) - all four characteristics as functions of the effective number of propagating modes and of the distance from the source. Inasmuch as the frequency field-correlation "radius" does not depend on the distance from the source and on the frequency of sound waves, in a rough approximation, it characterizes the body of water as a whole. References 8.

### Structure of Acoustic Fields in Water Layer Excited by Source in Air

937K0037B Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 38 No 4, Jul-Aug 92 (manuscript  
received 17 Jul 91) pp 609-615

[Article by Ye.L. Borodina, A.I. Khilko, and V.N. Shirokov, Institute of Applied Physics at Russian Academy of Sciences; UDC 537.268]

[Abstract] Excitation of a water layer (density  $\rho_1$ , speed of sound  $c_1$ ) by a sound source in the air is considered, the acoustic field in such a waveguide being analyzed on the basis of the model of a water layer between an upper half-space occupied by air in which  $c_0 < c_1$  and a lower half-space occupied by a liquid in which  $c_2 > c_1$  below. Such a waveguide thus differs from the Pekeris shallow-sea model and from a triple-layer one where  $c_1 < c_0 < c_2$ . The point source of sound and the receiver at a distance  $r$  from it are located, respectively, at an altitude  $h$  above and at a depth  $z$  below the upper waveguide boundary. A spherical wave leaving the sound source is represented as the sum of plane waves and the pressure field in the waveguide layer is described accordingly, also so as to satisfy the given boundary conditions including absence of radiation at infinity. The corresponding dispersion equation  $D(k) = 0$  ( $k$  - horizontal projection of wave vector) differs from that for a Pekeris waveguide by including a small  $\rho_0/\rho_1$  term which vanishes when the upper waveguide boundary is perfectly soft. Three acoustic characteristics of such a waveguide have been evaluated numerically, considering propagation of the normal waves as well as of the floor wave and the surface wave upon excitation by a sound source in the air with a 25-150 Hz frequency range, namely: 1) frequency dependence of sound attenuation  $20\log(p/p_0)$  in the waveguide, with the frequency of sound  $\omega$  normalized to  $c_1/H$  ( $H$  - depth of waveguide); 2) downward vertical  $z$ -profile of sound intensity  $20\log(p/p_0)$  in the waveguide, 3) dependence of sound attenuation at the receiver on its distance  $r$  from the source. The results of numerical calculations and analysis indicate that a low-frequency acoustic field is principally the field of the surface wave, all normal waves leaving such a waveguide, while a high-frequency acoustic field is the resultant field of the normal waves and the marginal floor wave. Near the waveguide-air boundary, moreover, the amplitude of normal and marginal bottom waves is found to be proportional to the  $\rho_0/\rho_1$  ratio. Figures 4; references 5.

**Liquid-Crystal Sensors**

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in Russian Vol 38 No 4, Jul-Aug 92 (manuscript  
received 10 Oct 91) pp 616-625

[Article by Yu.V. Bocharov, O.A. Kapustina, and V.N. Reshetov, Institute of Acoustics imeni N.N. Andreyev at Russian Academy of Sciences]

[Abstract] The design of optical transducers using liquid crystals as sensors with fiber-optic input leads is analyzed, specifically being considered nematic liquid crystals on account of their favorable light polarization modulation characteristics. They are shown to be suitable for pressure variation transducers and temperature fluctuation rate transducers as well as linear vibration velocity and acceleration transducers and angular vibration velocity and acceleration transducers. These transducers convert the respective input quantities into optical signals, preferably having the crystal under shear strain with "overflow" rather than under plain shear alone. The frequency characteristic of each conversion coefficient is calculated in accordance with the respective signal conversion law, the design specifications then being established on this basis. The results of a numerical analysis together with experimental data indicate the feasibility of building such transducers with a sensitivity to input signals covering the 0.01-100 Hz frequency range and a dynamic range of 120 dB in weak alternating physical fields. Figures 7; references 9.

**Peculiarities of Acoustic Imaging of Ocean Floor With Multielement Antenna Arrays**

937K0037D Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 38 No 4, Jul-Aug 92 (manuscript  
received 10 Oct 91) pp 626-630

[Article by A.V. Bunchuk, V.I. Volovov, and A.I. Govorov, Institute of Acoustics imeni N.N. Andreyev at Russian Academy of Sciences]

[Abstract] Formation of an acoustic image of the ocean floor by plane space-diverse multielement arrays of receiver antennas is analyzed, the sound radiator with a  $\theta$  wide vertical radiation pattern located near the water surface and covering a floor area approximately  $H\theta$  wide ( $H$  - depth of floor) when  $\theta \ll 1$ . A receiver antenna of length  $L$  located near the sound radiator picks up acoustic signals reflected by the ocean floor and records the acoustic field, an acoustic image of the given ocean floor segment then being produced mathematically. Use of the two-dimensional Fresnel transform is considered for relating the sought acoustic image of an  $H \geq 1000$  m deep ocean floor to the measured acoustic field above it. The range of size relations between  $L$ ,  $\theta$ , and  $H$  within which this method will work is established first, and the square of the modulus of the transform modulus is then calculated accordingly. Acoustic images are thus obtained by successive soundings from a moving vessel so that they will overlap and combine into an image of the entire given ocean floor segment. An analysis of

images obtained in this way reveals that only the distribution of the acoustic field intensity near the ocean floor and thus only the distribution of the back-scattering coefficient can be reconstructed by this method. A negative factor especially detrimental to the reliability of ocean floor sounding for iron-manganese deposits is the "specular highlight", which unjustifiably widens the dynamic range of image brightness. Its effect will be abated but not completely eliminated by image correction or by compensation of the nonuniform angular distribution of the reflection coefficient. It therefore is still necessary to omit the central portion of each individual image in the averaging process. An acoustic image of a 240 m wide and over 4000 m long ocean floor segment was actually obtained by sounding with 10 kHz signals over periods of 1.5 s from a vessel drifting at a velocity of 1.5-2.0 knots. Figures 2; references 11.

**Frequency Spectra of Acoustic Signals Reflected by Ocean Surface and Propagation Characteristics of Wind-Induced Surface Waves**

937K0037E Moscow AKUSTICHESKIY ZHURNAL  
in Russian Vol 38 No 4, Jul-Aug 92 (manuscript  
received 27 May 91) pp 644-653

[Article by A.V. Volkova and Ye.A. Kopyl, Institute of Acoustics imeni N.N. Andreyev at Russian Academy of Sciences; UDC 551.463]

[Abstract] Experimental studies of equatorial ocean waters have been made during the past few years, their object being to measure the frequency characteristics of acoustic signals scattered by a rough ocean surface. Transceiver antennas with both vertical and horizontal radiation patterns not wider than 20° in the low-frequency range were dropped from the vessel into the water as far as 200 m down below the ocean surface, while the vessel drifted, so that signals were scattered at low angles by surface segments at least 200 m and thus sufficiently far away from the vessel. The sound source radiated pulses in packets covering an area not larger than that covered by the major lobe of the antenna radiation pattern, the duration of each covering at least 100 carrier wave periods and the signal frequency being varied over the 1-80 kHz audio range. Measurements were made in daylight, when scattering of sound by subsurface layers was negligible, in rough weather with wind velocities in the 2-10 m/s range. Theoretical calculations were made using the two-scale model of a scattering surface and a description of surface roughness by the  $J(K, \beta) = G(K)Q(K, \beta)$  spectrum ( $K$  - wave number of surface harmonic,  $\beta$  - angle from the wind direction ranging from 0 to 180°), the wave number  $K$  and the frequency  $\Omega$  of a surface harmonic being related through the dispersion equation  $\Omega = (gK + \gamma K^3)^{1/2}$  (gravitational acceleration  $g = 9.81$  m/s<sup>2</sup>, ratio of surface tension per unit length to water density  $\gamma = 0.000073$  m<sup>3</sup>/s<sup>2</sup>). A numerical analysis pertaining to acoustic signals scattered by the water surface has yielded the azimuth dependence of their Doppler frequency shift and the dependence of the frequency shift of their only one

spectral maximum on the signal frequency, their spectra not depending on the azimuth. A numerical analysis pertaining to wind-induced surface waves has yielded the velocity characteristics of resonance surface crests, namely the dependence of their Doppler velocity and phase velocity on the signal frequency. The results of this analysis indicate that their Doppler velocity (measured) can be much higher than their phase velocity (calculated). Possible causes of such a discrepancy are nonlinear interaction of surface waves in the two different scale fractions or underdevelopment of the surface roughness, both factors unaccounted for in the calculations and the second factor being particularly significant at high wind velocities. Another possible cause of that discrepancy in the high frequency range is unaccounted for formation of air bubbles in the subsurface layers, their intensity increasing with increasing wind velocity. The authors thank N.B. Andreyeva for assistance in obtaining the results and for discussing them. Figures 5; references 15.

**Effect of Scattering by Uneven Ocean Floor on Transformation of Mode Spectrum of Low-Frequency Sound Wave in Oceanic Bottom Waveguides ]**

937K0037F Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 38 No 4, Jul-Aug 92 (manuscript received 26 Sep 91) pp 678-682

[Article by N.S. Gorskaya, M.A. Rayevskiy, and I.M. Starobinets, Institute of Applied Physics at Russian Academy of Sciences; UDC 534.28]

[Abstract] Scattering of a low-frequency wave by an uneven shallow-water ocean floor is analyzed, in the diffusion approximation, for the effect of the ocean floor unevenness on the evolution of normal acoustic modes in the bottom waveguide layer. A refracting waveguide with a certain vertical wave velocity profile is considered above a half-space occupied by a sound-absorbing acoustically isotropic fluid representing the seabed. The mode spectrum of near the sea floor is obtained from the transfer equation of the corresponding diffusion boundary-value problem. The energy diffusion coefficient is obtained from its relation to the probability of mode-to-mode transition, in the Wentzel-Kramers-Brillouin approximation for the eigenfunctions of waveguide modes. This approximation is also used for the decrement due to absorption by the sediment, assuming a typically for an ocean linear dependence of the volume absorption coefficient on the sound wave frequency. The

solution to the diffusion boundary-value problem is sought in the form of a series of exponential terms and is found following solution of its diffusion equation by separation of variables. For specificity is considered a Gaussian spectrum of ocean floor unevenness, an analytical solution in this case not being possible and a numerical solution therefore being resorted to. The results confirm the anticipated appreciable modification of the acoustic mode spectrum by the ocean floor unevenness, with an attendant sound energy attenuation along the waveguide. Figures 2; references 11.

**Input Impedance of Radially Excited Cylindrical Layer With Periodically Spaced Rigid Inserts**

937K0037G Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 38 No 4, Jul-Aug 92 (manuscript received 19 Sep 91) pp 764-766

[Article by V.Ye. Glazanov and I.L. Rubanov, Central Scientific Research Institute "Morfizpribor" (Marine-Physical Instruments); UDC 534.232]

[Abstract] Radial excitation of a discontinuous cylindrical layer is considered, a perfectly rigid material filling uniformly spaced gaps and thus forming a periodic array of inserts. The acoustic input impedance of such a cylindrical layer, obtained from the solution to the corresponding boundary-value problem, is  $Z_i = -j[A_0 J_0(kc_0)/J_1(kc_0) + B_0 N_0(kc_0)/N_1(kc_0)] (J_{0,1} - \text{Bessel functions of the first kind}, N_{0,1} - \text{Neumann functions}, k - \text{wave number}, c_0 - \text{clearance from shield}, A_0, B_0 - \text{coefficients})$ . The input impedance of such a cylindrical layer with empty gaps was obtained earlier (V.Ye. Glazanov, I.L. Rubanov; AKUSTICHESKIY ZHURNAL, Vol 37 No 2, 1991) from the solution to that corresponding boundary-value problem. Numerical calculations were made for a cylindrical layer with six inserts and with a relative wave impedance  $m = 0.1$  (referred to that of an otherwise identical solid cylindrical layer), assuming that the density of the layer material is equal to the density of water. These calculations have yielded two characteristics of such a cylindrical layer: 1) dependence of its relative input impedance (referred to that of a solid one) on the coverage ratio, 2) frequency dependence of its resonance wave thickness. A comparison of the results with analogous ones for such a cylindrical layer with empty gaps indicates that rigid inserts increase the inertia component of its input impedance and lower the resonance frequency (corresponding to  $Z_i = 0$ ) of the shield. Figures 2; references 1.

**Status of and Outlook for Shock-Free Printers With Liquid-Crystal Light Modulators**

937K0024A Moscow *ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFII* in Russian Vol 37 No 5, Sep-Oct 92 (manuscript received 15 Dec 91) pp 344-350

[Article by V.A. Alekhin, O.B. Aleyev, Ye.A. Levitskaya, Ye.P. Pozhidayev, and A.A. Sergeyev, Moscow Institute of Radio Engineering, Electronics, and Automation; UDC 621.78:681.327.11]

[Abstract] Following a review of the state of the art in electrophotography, a new class of shock-free printers using liquid-crystal light modulators is described and their operation analyzed. Most such printers use ferroelectric chiral smectic C\* liquid crystals featuring spontaneous polarization of molecules and a high response speed characterized by a short but temperature-dependent switching time constant  $\tau = \gamma/(P_c E)$  ( $\gamma$  - dynamic viscosity,  $P_c$  - polarization constant,  $E$  - electric field intensity). Their optical transmission coefficient for  $\gamma$ -wavelength radiation  $T = T_0 \sin^2 2\omega \times \sin^2(\pi \Delta n d / \gamma)$  ( $\omega$  - angle of rotation of the polarization plane equal to  $2\theta$ ,  $\theta$  - angle of director rotation,  $d$  - thickness of crystal layer,  $\Delta n$  - dispersion of refractive index). In order to completely switch the polarization of the applied voltage, it is necessary that the director rotate through a  $\theta = 22.5^\circ$  angle. Very thin ( $d < 1.7 \mu\text{m}$ ) and very thick ( $d > 10 \mu\text{m}$ ) liquid-crystal layers exhibit achromatism. As the thickness of a liquid-crystal layer is varied over the intermediate range, the transmission coefficient passes through maxima and minima. An important property of liquid-crystal light modulators is their ability to store input for periods of time ranging from a few milliseconds to several minutes or even hours, which facilitates dynamic control with multiplexing. The printer head of a typical such printer, the Casio LCS-240, contains a 20 W fluorescent slit lamp as the light source, a cylindrical lighting lens, a layer of liquid-crystal shutters between two glass plates as wide as a printed page, and an array of graded-index or rod lenses scanning the photosensitive drum, also one board with electronic control circuitry mounted behind the lamp and two laterally mounted boards carrying arrays of densely spaced (up to 12/mm) electrodes controlling the liquid-crystal layer. A compact copier for the Scientific-Industrial Association "Geofizika" has been developed at the Scientific Research Institute of Electrography in Vilnius, this A 4012E Start table model making 12 copies in one minute. Various smectic liquid-crystals are meanwhile being developed at the Scientific Research Institute of Organic Semiconductors and Dyes in Moscow. One such liquid-crystal mixture, the ZhKS-65, switches the polarization within 100  $\mu\text{s}$  while it maintains a high but also temperature-dependent contrast at temperatures within the 24-36°C optimum range. At the Moscow Institute of Radio Engineering, Electronics, and Automation has been already been developed and tested a format A4 printer head with a resolving power of 8-12 points/mm and a not longer than 5 ms printing cycle. An great

advantage of these printers is that they operate with low control voltages and draw little power. Figures 4; tables 1; references 12.

**Light Modulator for Electrophotographic Liquid-Crystal Printer**

937K0024B Moscow *ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFII* in Russian Vol 37 No 5, Sep-Oct 92 (manuscript received 1 Dec 91) pp 350-354

[Article by V.A. Alekhin, V.V. Kuznetsov, and V.D. Paramonov, Moscow Institute of Radio Engineering, Electronics, and Automation; UDC 772.932.45]

[Abstract] A light modulator for electrophotographic printers is being developed which should make it possible to print 260 mm wide pages at a speed of 10-12 per minute with a 12-16 points/mm resolution and an up to 10:1 contrast. The modulator is an optoelectronic module which contains a 200 mm long linear array of liquid-crystal shutters spaced 200  $\mu\text{m}$  apart and forming a thin layer between two parallel glass plates glued together with an appropriately wide gap. The material of this layer is a ferroelectric chiral smectic C\* liquid crystal. One thousand transparent signal electrodes are mounted on the inside surface of a control board, a 200 mm wide glass plate, 200  $\mu\text{m}$  apart with 500 contacts 400 mm apart on each side of that plate. A solid transparent counter electrode and opaque diaphragms are mounted on the inside surface of another narrower glass plate. The outside surface of each glass plate is coated with a polarizing film. The optical exit aperture is 2000 x 0.2  $\text{mm}^2$  large slit. The modulator is designed to operate with a control voltage of 15-20 V. The best control scheme for it was found to be the hybrid integral microassembly used in thermal printer heads. It consists of twelve A-1138 LSI circuits with 3120 CMOS transistors needed for a 240-bit series-parallel buffer register, a 240-bit parallel-parallel buffer memory register, 240 output switches (transistors), a control module, and a synchronizer module - all on a 28 x 45  $\text{mm}^2$  large pyroceramic board with 10 inputs and with 240 drains for the output switches. Experimental prototypes of this light modulator were tested with 20  $\mu\text{m}$  thick and with 10  $\mu\text{m}$  thick chiral smectic C\* liquid crystals. They were tested for dynamic and luminotechnical characteristics, to determine the feasibility of using them in shock-free electrographic printers. Their switching can be controlled in two ways: 1) elastically, with the switching voltage retained after switching and a voltage of opposite polarity applied for turn-off, 2) viscoelastically, with retention in the metastable twisted state. As light source was used a KGM-24V-150W metal-halide lamp, illuminating the liquid crystal through a fiber-optic circle-to-line transformer bundle. A model OR-000 projector objective (focal length  $f = 150 \text{ mm}$ , magnification  $\beta = -1$ , stop number  $K = 4.7$ ) projected a crystal fragment the surface of a photosensitive drum rotating with a tangential velocity of 100 mm/s. Figures 4.

### Electrophotographic Data Carriers

937K0024C Moscow ZHURNAL NAUCHNOY I  
PRIKLADNOY FOTOGRAFIИ I KINEMATOGRAFIИ  
in Russian Vol 37 No 5, Sep-Oct 92 (manuscript  
received 9 Mar 92) pp 372-374

[Article by A.I. Popov, Moscow Institute of Power  
Engineering; UDC 537.311]

[Abstract] The characteristics of electrophotographic data carriers which determine their suitability for diverse applications such as printing and color electrography are examined from the standpoint of the respective requirements. It is generally necessary to either expand or shift their photosensitivity range toward longer waves by appropriately modifying the wavelength dependence of the photoelectric effect and to increase the electrophotographic sensitivity, while not only maintaining a low rate of decrease of the charging potential  $dV/dt$  in darkness and a low residual potential after exposure as well as a high contrast but also maintaining a high copying capability. For an analysis of the interrelation between these characteristics are first considered selenium layers, these layers with maximum photosensitivity in the blue region of the spectrum satisfying several other requirements. Replacing vitreous selenium with a semiconductor featuring which has a narrower energy gap will shift the photosensitivity range as desired, but a consequence of its correspondingly higher electrical conductivity will be faster decrease of the charging potential in darkness. Doping selenium

with anywhere from a few to tens of atom.% As, Ge, or other impurity element will, moreover, lower the drift mobility of photogenerated charge carriers and increase their recombination rate so that the photosensitivity of such a layer will be lower and the residual potential will be higher. Layers of selenium alloys such as Se-Te alloys are characterized by a lower crystallization activation energy and, therefore, have a lower copying capacity. Another possibility is use of multilayer carriers. Cladding a semiconductor layer with a dielectric layer on which the latent electrostatic image will be formed allows use of a semiconductor material with a narrower energy gap, inasmuch as its higher electrical conductivity will not degrade the performance, but the presence of a dielectric layer complicates the electrophotographic process and this option is not desirable. Joining several layers of different semiconductors or including a variband layer whose chemical composition and energy gap width vary across its thickness, on a silicon or selenium substrate, are most promising. This is demonstrated by the electrophotographic performance characteristics of carriers with new structures: a- $\text{Si}_x\text{N}_{1-x}\text{H}$ /a-Si:H, a-Si:H/a- $\text{Si}_x\text{Ge}_{1-x}\text{H}$ , Se/Se $_x$ Te $_{1-x}$ , Se/Se $_x$ Bi $_{1-x}$ , and others (a - denoting an amorphous material). A gradient of the energy gap width gives rise to an opposing electric field for photogenerated holes, which lowers the recombination rate and thus increases the absolute magnitude of the electrophotographic sensitivity: that of a Se-Bi carrier being  $0.5\text{-}0.7 \text{ lx}^{-1}\text{s}^{-1}$  to 430-650  $\mu\text{m}$  light, that of a Se carrier being only  $0.3\text{-}0.5 \text{ lx}^{-1}\text{s}^{-1}$  and only to 400-470  $\mu\text{m}$  light. Figures 3.

**New Materials for Thermoelectric Sources**  
937K0020A Moscow *DOKLADY AKADEMII NAUK*  
in Russian Vol 324 No 3, May 92 pp 567-570

[Article by N.S. Lidorenko, Z.M. Dashevskiy, L.D. Dudkin, R.V. Skolozdra; UDC 539.293]

[Abstract] New materials for current sources are investigated and the following selection criteria are considered: accessibility, low cost, and low vapor pressure. A group of ternary transition material-based compounds with Sn and Sb which crystallize as  $MgAgAs$ —a  $CaF_2$  superstructure—are selected as the basis. The properties of  $TiNiSn$ ,  $ZnNiSn$ , and  $HfNiSn$  stannides characterized

by an unusually high resistivity compared to other intermetallic compounds are examined in greatest detail. The dependence of the electric conductivity, thermoelectric coefficient, and unit power of  $MNiSn$  ternary samples ( $M=Ti$ ,  $Zr$ ,  $Hf$ ) is plotted and the chemical composition of the ternary compounds is summarized. The samples are tentatively divided into two groups according to the carrier concentration. An analysis of the curves and thermal conductivity at room temperature and the possibility of decreasing the lattice component of conductivity by increasing temperature as well as by isovalent doping make it possible to speculate that the above compounds can be used for making electronic thermoelectric materials with a mean efficiency of  $0.5 \times 10^{-3} K^{-1}$  within a 300-1,000K temperature range. Figures 1; tables 2; references 6: 4 Russian, 2 Western.

**Methods of Analyzing Cyclic Search Procedures for Wideband Signal**

937K0055A Moscow RADIOTEKHNIKA in Russian  
No 5-6, May-Jun 92 (manuscript received 21 Jun 91)  
pp 7-10

[Article by V.I. Zhuravlev and N.N. Kravchenko; UDC 612.396.946]

[Abstract] Two methods of analyzing cyclic search procedures for composite discrete wideband signals are compared, both methods involving two detection stages. The method of generating functions (J.K. Holmes and C.C. Chen; IEEE TRANSACTIONS, Vol COM-25 No 8, 1977) is based on a signal graph which includes two absorbing states which characterize points of correct and false lock-in respectively along with L irreversible transition states. The method of matrices based on the theory of finite Markov chains (P.M. Hopkins; IEEE TRANSACTIONS, Vol COM-25 No 8, 1977) involves finding the  $L \times L$ -dimensional probability Q-matrix of transitions prior to exit from irreversible states and the  $L \times 2$ -dimensional probability  $R_0$ -matrix of transitions from irreversible states to either of the two absorbing states which characterize correct or false lock-in respectively. While the second method is shown to be preferable when the signal base is relatively short and standard transformations of the signal graph are difficult, the first method including use of the Maison-Zimmerman formula (1963) may be preferable in some cases. Figures 2; references 5.

**Improving Resolution of Direction Finding for Wideband Signals**

937K0055B Moscow RADIOTEKHNIKA in Russian  
No 5-6, May-Jun 92 (manuscript received 13 Mar 91)  
pp 11-14

[Article by E.A. Maltsev; UDC 621.391]

[Abstract] Raising the spatial correlation matrices of incoming wideband signals for finding their directions of their arrival from different sources is shown to improve the resolution of superresolution direction finding algorithms as well as the resolution of Keupon's method in the finite-sampling mode. A formula is derived for raising the correlation matrix to the second power by using the expression for elements of the exact spatial correlation matrix of a single wideband signal with a flat finite spectrum (O.S. Litvinov; RADIOTEKHNIKA I ELEKTRONIKA, Vol 27 No 11, 1982) and by representing this matrix as a Hadamard product. The effectiveness of resolving signals by using the fourth power of the correlation matrices is demonstrated on two wideband signals arriving at a linear antenna array of 10 equidistant elements. The momentary spectrum of each signal was obtained by 256-point discrete Fourier transformation in a 21-frequency processing channel, the first-degree correlation matrix not having been able to distinguish the two sources. The mechanism which improves the resolution is shown to be associated with the properties of the spatial correlation matrices of

incoming signals and to have nothing to do with the noise level. The author thanks A.M. Kuzminskiy and O.N. Galchenkov for helpful consultations. Figures 5.

**Matched Acoustoelectric Filters for Phase-Shift-Keyed Signals**

937K0055C Moscow RADIOTEKHNIKA in Russian  
No 5-6, May-Jun 92 (manuscript received 15 Apr 91)  
pp 15-19

[Article by A.S. Kozlov and N.I. Tolstoukhov; UDC 621.396.6]

[Abstract] Two versions of matched surface-acoustic-wave filters for 4-phase phase-shift-keyed signals are described, surface acoustic waves being generated by a short video pulse. The input transducer of the single-channel filter is an interdigital one with two non-apodized combs of equidistant metal bar electrodes, the output transducer having two arrays of generally not equidistant electrodes connected to the busbars of the summing device. The sound guide is formed by a piezoelectric quartz crystal with an ST-cut and an X-cut. The two input transducers of the two-channel filter are identical and similar to the input transducer of the single-channel filter, but its two output transducers are coded. The two input transducers are connected in parallel and so are the correspondingly coded output transducers. A design analysis of these filters is followed by a performance evaluation, experimental prototypes having been tested on 4-phase 255-position PSK signals with a 20 MHz modulation frequency riding on a 120 MHz carrier. Oscillograms of their pulse responses and convolution signals indicate a not wider than 1 dB deviation of the amplitude ratios in the largest side lobe and of the correlation peak in convolution signals from the respective nominal ones. Figures 4; references 4.

**Problems in Theory and Practice of Radio Apparatus Operation and Performance During Interference**

937K0055D Moscow RADIOTEKHNIKA in Russian  
No 5-6, May-Jun 92, pp 32-34

[Annotation of by M.M. Grozmin, deposited under No 1882-sv at Center of Scientific and Technical Information "Informsvyaz" UDC 621.321:621.372:621.391:621.396:001.63]

[Abstract] After about 100 years of radio engineering, there are still many problems subject to controversy and especially so when theory and practice do not agree. In radiolocation using a single-hump indeterminacy function, for instance, no definitive criteria have yet been established regarding detection, resolution, and measurement of two signals and particularly composite ones. The first volume of this book deals with such problems in the four main areas of radio engineering concern: circuits, signals, communication, and radar. The second volume, consisting of three parts, interference immunity

is treated respectively as: 1) the ability of standard AM or FM receiver channels including pulsed ones to resist noise-like, directly or indirectly incident uniform, or other interference, this ability being quantified in terms of the interference suppression coefficient at the channel output; 2) the ability of radio apparatus (detectors, meters, especially direction finders with automatic angle tracking) to perform assigned functions in the presence of interference, which often requires interference abatement, electromagnetic compatibility, shielding, or other countermeasures; 3) the ability of radio apparatus such as standard receiver channels and detectors as well as PCM radio channels to retain their performance characteristics upon changes in the characteristics of noise-like interference or of detectors with automatic gain control and as well as robust detectors and meters with compensation to retain their performance characteristics upon changes in the characteristics of signal-like noise, new criteria being proposed here which differ from the conventional ones based on sensitivity or adaptation theory. The third volume covers modern design requirements in terms of cost effectiveness and thus economic as well as technical aspects.

**Statistical Multilevel-Threshold Method of Determining Intervals of Existence of Pulse Signal Submerged in Low-Frequency and High-Frequency Interference**

937K0055E Moscow RADIOTEKHNIKA in Russian No 5-6, May-Jun 92 (manuscript received, after completion, 26 Jun 91) pp 35-42

[Article by A.V. Simkin, O.G. Svetnikov, B.S. Maslenikov, and V.M. Grits; UDC 621.382]

[Abstract] The problem of detecting and reconstructing a pulse signal submerged in low-frequency and high-frequency interference is solved by the statistical multi-level-threshold method, namely by determining the intervals on which such an incoming signal can exist at all given threshold levels. This method involves formation of a set of threshold levels by uniform quantization so as to cover the dynamic range of pulse amplitude variation and parallel establishment of a set of a posteriori probabilities that the signal will exceed each threshold level. The method is demonstrated on an incoming sequence of pulses not only with random amplitudes and periods but also beginning and ending at random instants of time. The signal is reconstructed from a sequence of periodic discrete readings, each being the sum of the signal plus both a low-frequency interference and a high-frequency interference normally distributed with zero expectation values and with respective corresponding dispersion. It is reconstructed as a multiposition estimate from two-position output states in the set of threshold levels, an a'priori probability being established according to a recurrence algorithm and mean-square errors being selected as the criterion for estimation accuracy. The results of a numerical simulation by this method indicate that slowly varying low-frequency interference and fast varying high-frequency

interference are effectively removed from the sequence of periodic readings while the signal duration is retained at all threshold levels. Figures 2; references 7.

**Automatic Frequency Shift Compensation in Fluctuating Sequence of Radio Pulse With Variable Repetition Rate**

937K0055F Moscow RADIOTEKHNIKA in Russian No 5-6, May-Jun 92 (manuscript, after completion, 6 May 91) pp 57-61

[Article by V.I. Kurpovich; UDC 621.396.96]

[Abstract] A frequency discriminator with an extended unambiguous characteristic is proposed for preventing automatic frequency shift compensation, used for coherent signal reception and for effective interference suppression, from pulling into false zero frequency shift states. As an incoming signal is considered a sequence of radio pulses arbitrarily, could be noise-like, modulated and having an either fluctuating or constant repetition rate. While its carrier frequency and time delay are constant, but its usually centered Gaussian frequency shift varies slowly, characterized by a complex envelope with random amplitude and phase. The frequency discriminator contains two phase detectors and an oscillator preceded by smoothing circuits, as does a conventional frequency discriminator with two filters, but instead of using these high-frequency filter and low-frequency filters matched to the structure of an incoming pulse signal by means of two fixing devices and a generator of video pulses, it utilizes not only the correlations between like quadrature components of the incoming signal as well those between its orthogonal ones for appropriate cross-multiplication. This scheme ensures pulling of the automatic frequency shift compensation to the true zero and not to any of the two lateral false ones. Figures 4; references 3.

**Attainable Interference Immunity of Digital Reception of Binary Radio Signals Appearing With Quasi-Harmonic Gaussian Noise**

937K0055G Moscow RADIOTEKHNIKA in Russian No 5-6, May-Jun 92 (manuscript received, after completion, 30 Sep 91) pp 62-64

[Article by Ye.A. Smirnov; UDC 621.391.019.4]

[Abstract] The attainable interference immunity of digital reception of binary radio signals appearing with a quasi-harmonic Gaussian noise is estimated by the author's method (Ye.A. Smirnov; RADIOTEKHNIKA, No 10, Oct 90), typically at the output of an intermediate-frequency amplifier feeding a tuned high-Q tank circuit. The probability of reception error is estimated for readings taken within a certain time period at the discretizer with filter output when at its input there appears a binary sequence of radio pulses accompanied by a quasi-harmonic noise with a given spectral density. The algorithm has been applied to telegraph signals, the

results of computer-aided calculations indicating that, as the number of readings taken within the signal period increases, the error probability decreases fast to the level which corresponds to maximum attainable interference immunity of continuous signal processing: about  $1.5 \times 10^{-2}$  in amplitude telegraphy,  $8 \times 10^{-4}$  in frequency telegraphy,  $4 \times 10^{-6}$  in phase telegraphy. The discretization frequency should be selected so as to allow for either 20-30 or 40-45 readings within the signal period, without any decrease of interference immunity. Figures 1; references 2.

#### Comparative Evaluation of Methods of Complementing Digital Signals for Interpolation and Parallel Algorithm of Signal Reconstruction

937K0055H Moscow RADIOTEKHNIKA in Russian No 5-6, May-Jun 92 (manuscript received 23 Jul 90) pp 72-75

[Article by O.A. Vakulskiy and A.V. Zhuk; UDC 621.396.4:621.372.54]

[Abstract] A way to reduce the interpolation error with a minimum possible calculation volume in processing of digital signals is proposed, symmetrization of the incoming digital signal (V.A. Suchilin; RADIOTEKHNIKA, No 5, May 89) already being very effective but requiring twice as many calculations. The proposed scheme involves a discrete Fourier transformation of the digital signal and its subsequent reconstruction by an inverse discrete Fourier transformation, the nonzero readings of the signal spectrum thus being complemented with zeroes so that that a parallel algorithm of this inverse discrete Fourier transformation and signal reconstruction becomes realizable. Complementing the original digital signal with readings of discretized exponential functions prevents appearance of the Gibbs phenomenon. This lengthens the interpolated digital signal somewhat but not very significantly. Although symmetrization is still the most effective method with regard to accuracy, the method proposed here is more economical in terms of computer time. Figures 2; references 3.

#### Simulation of Cepstral Processing for Synthesis and Analysis of Composite Signals

937K0055I Moscow RADIOTEKHNIKA in Russian No 5-6, May-Jun 92 (manuscript received, after completion, 29 Nov 90) pp 76-80

[Article by B.A. Shchukin, V.B. Aleksandrov, and Ye.V. Masharov; UDC 621.391:621.396]

[Abstract] Synthesis and analysis of composite signals by cepstral rather than spectral processing is considered, the effectiveness of this method being demonstrated by the results of computer-aided simulation of spectral and cepstral characteristics. As a signal to be synthesized is selected a minimum-shift phase-shift-keyed signal: the convolution in time of a  $0, \pi$  phase-shift-keyed signal  $s_{PSK}(t)$  (index  $m=1$ , modulation frequency  $\omega_1$ , carrier

frequency  $f_0$ ) and the exponentially decaying in time sinusoidal Gaussian envelope  $h(t)$  of the pulse response of a Gaussian radio filter (repetition rate of pulses under envelope  $\omega_2$ , carrier frequency  $f_0$ ) that it is possible in this way to represent a convolution signal as the sum of its components and to reconstruct the keying function upon identification of the characteristic cepstral signal indicators. Figures 3; references 1.

#### Regulation Noise and Condition for Stability of Gradiental Adaptive Phased Antenna Array

937K0055J Moscow RADIOTEKHNIKA in Russian No 5-6, May-Jun 92 (manuscript received, after completion, 10 Dec 90) pp 85-89

[Article by M.V. Ratynskiy; UDC 621.391]

[Abstract] Tuning of a gradiental adaptive phased antenna array for maximum signal-to-(interference+noise) ratio in accordance with the Brennan-Reed recurrence relation (L.E. Brennan and I.S. Reed; IEEE TRANSACTIONS Vol AES-9 No 2, Feb 73) is considered and the power of regulation noise without a separate main channel within a discrete time period including the transient period is estimated. This power is shown to consist of two parts, one representing the power of steady-state regulation noise one indicating the condition for stability: in order that the noise power decrease after successive iterations, it is necessary that the multiplier of the transient-state regulation power not exceed the 0-1 range of values. Digital simulation of tuning a linear antenna array of 16 equidistant elements with a uniform amplitude distribution in the presence of  $M=1$  or  $M=6$  interference sources has revealed that the power of regulation noise can by far exceed the power which corresponds to the average magnitude of the mean weight vector  $W$  of the spatial filter, this conclusion having been confirmed by an experimental study. The weight vector approaches its optimum value  $W_{opt} = S/aR$  ( $S$  - reference vector determined by the arrival angle of the expected useful signal,  $R$  - correlation matrix of incoming signals,  $a$  - scalar constant which determines normalization of the weight vector at the limit  $W(\infty)$ ). The condition for stability with respect to regulation noise is shown to depend on the number of interference sources and, when there are more than one, to be  $0 < \mu a^2 < 2/M+1$  ( $\mu$  - scalar constant which determines the convergence rate and the degree of stability of the transient process,  $\lambda_1$  - largest eigenvalue of correlation matrix  $R$ ,  $M$  - number of interference sources). This condition is more stringent than the Brennan-Reed conditions that  $0 < \mu a^2 < \lambda_1 \leq 1$ . Figures 6; references 7.

#### Combined Equipment for Users of Satellite and Hyperbolic Radionavigation Systems

937K0051A Moscow RADIOTEKHNIKA in Russian No 4, Apr 92 pp 3-13

[Article by M. S. Yarlykov; UDC 621.396]

[Abstract] Satellite navigation systems (SNS) NAVSTAR, NAVSAT, GLONASS, etc, which are designed for providing global, high accuracy navigation for various users, in many regions operate along with the pulse-phase hyperbolic systems for long range navigation (LRN) of the LORAN-C type. The feasibility of a combined application of the SNS and LRN is very attractive. Optimal or sub-optimal algorithms for a complex information processing (KIP) on board with a combined use of the SNS, LRN and an inertial navigation system (INS) can be developed based on the Markov theory for non-linear estimates of random processes. Synthesis of the structure and the problem of determining the parameters of the on-board KOI system with a combined use of the SNS, LRN was solved here, by applying the methods of the above theory, for a case of a mobile user, for example an airplane. Quantitative estimates of the structure noise immunity and accuracy were also obtained. Figures 7, references 9: 8 Russian, 1 Western.

#### Determination of Target Coordinates by Angle Measurements Data From a Mobile Receiving Point

937K0051B Moscow RADIOTEKHNIKA in Russian  
No 4, Apr 92 pp 14-19

[Article by Yu. G. Gulychev, A. A. Korotun, A. P. Manin, V. A. Motorkin; UDC 621.396]

[Abstract] The existing methods for determining the spatial position of targets with passive angle measuring systems are based either on triangulation or assume that there is an additional radial velocity channel for determination of the coordinates by a differential-geometrical method for computing the path. The identification of the trajectory parameters of the target can be made by a method which requires that the derivatives of the measured coordinates, up to the third order, be used in the developed algorithms. This imposes some limitations on the method. The feasibility is examined here for determining the coordinates of the target with data on angles only, produced by a single mobile direction finder without using information on the derivatives. Unlike the familiar equations for estimating the accuracy characteristics of the triangulation method of target location, no information is required on the target range, when applying the equations developed here. This constitutes an advantage of the approximate approach for estimating efficiency of the proposed algorithms for processing the radar information. The results of numerical computations demonstrated that the algorithms are also applicable in the presence of fluctuation errors in measurements of the azimuth and angle, which makes it possible to employ them with the angle measuring systems Figures 2, references 5 Russian.

#### Multialternative Invariant Detection of a Weak Fading Signal in the Background of a Steady-State Noise of Unknown Intensity

937K0051C Moscow RADIOTEKHNIKA in Russian  
No 4, Apr 92 pp 26-30

[Article by G. M. Bashin; UDC 621.396.96]

[Abstract] A multi-alternative decision making rule was developed for a non-coherent detection of a weak fading signal reflected from an object with known dimensions and unknown location in a background of a steady state interference of unknown intensity. For this rule, the probability of false alarm does not depend on the interference intensity. The relative losses in the threshold signal of a similar decision rule due to a priori uncertainty were investigated and compared to the threshold signal of the Niemann-Pierson, which is optimal for the known location of signal and the interference intensity. The obtained asymptotically invariant probability ratios and decision statistics are formed by selected averages of the elements of the analysed samples, requiring much fewer arithmetic operations than computation of invariant statistics, corresponding to all possible positions of the signal region. Figures 2, references 10 Russian.

#### Minimal Filtering of Pulsed FKM and Amplitude-Phase Keyed Signals

937K0051D Moscow RADIOTEKHNIKA in Russian  
No 4, Apr 92 pp 34-39

[Article by G. A. Sokolov; UDC 621.396.96]

[Abstract] By applying the statistical solution theory method of minimax estimates, a problem is examined of time resolution of pulsed FKM and amplitude-phase keyed signals with unknown initial phase and intensity for estimating the response of discrete normal random signals belonging to different assemblies with specified normalized correlation matrices and unknown dispersions. Methods are investigated for computation of linear filters of pulsed signals with random complex manipulation. The results of this study offer new possibilities for the analysis of optimal filtering problems with time resolution of pulsed signals, allowing a discrete representation. Figures 4, references 4 Russian.

#### Interference Immunity of Devices for Detection of Complex Radiosignals Based on a Combination of ASW and CCD Structures

937K0051E Moscow RADIOTEKHNIKA in Russian  
No 4, Apr 92 pp 39-43

[Article by V. V. Artyushin, A. V. Andreyev, A.V. Kozhakov; UDC 621.396.26]

[Abstract] Application of a combination of an acoustic surface wave (ASW) and charge coupled devices (CCD) for detection of wide-band signals is examined. An acousto-electric convolver with time integration on charge coupled devices (AECTI/CCD) is one of the most effective systems for processing wide-band signals (WBS). Because of the simplicity of executing the multiplication operations of high-frequency signals, and a multi-channel capacity, the (AECTI/CCD) are very effective for detection of wide-band signals under conditions of time-frequency uncertainty. An analysis is

made of the AECTI/CCT system noise rejection capacity operating in the wide-band mode under the assumption that a combination of a useful WBS, with much longer duration than the signal delay in the AEC, and a white gaussian noise with a zero average value are applied to the system input. Curves of the AECTI/CCD system signal-to-noise ratio as a function of the number of multiplying electrodes are provided. Figures 2, references 2 Russian.

#### **Detection of Signals With Phase Changes**

937K0051F Moscow RADIOTEKHNIKA in Russian  
No 4, Apr 92 pp 43-45

[Article by V. V. Piskorzh; UDC 621.396]

[Abstract] An algorithm is proposed for signal detection, which is insensitive to abrupt phase changes of the carrier by a  $\pi$  value in the observation interval. The examined problem arise during the signal search and detection in the radio communication channels employing a phase  $\pi$ -manipulation. This algorithm can be used for discrimination of orthogonal signals with phase jumps by  $\pi$  in the observation interval, and frequencies which take on a countable set of values. References 1 Russian.

#### **Potential Accuracy Characteristics of Estimating Radiosignal Frequency in an Optimal Acoustooptic Meter**

937K0045A Kiev IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA  
in Russian Vol 35 No 9-10, Sept-Oct 92 pp 49-51

[Article by V. I. Shcherbak, A. V. Parshutkin; UDC 621.376:681.325]

[Abstract] When determining the accuracy characteristics of optimal discriminators used for estimating the space parameters of optical waves, it is assumed that the space processing and the time processing of the input signal can be completely separated. However, with an acoustooptic spectral analyzer, the situation is different. An analysis is made here of the potential accuracy characteristics of an optimal, in terms of maximum likelihood, frequency meter with an acoustooptic modulator, operating in the Bragg diffraction mode, taking into account the spatial, as well as the time processing of the optical wave after the modulator. It is assumed that the processing of the signal is made in the background of additive white noise. In this case, for an optimal meter, which realizes the maximum probable estimate of frequency, the theoretically maximal covariations of errors are completely determined by the corresponding coefficients of an information matrix. It was demonstrated that with a spatial processing the rms deviation of frequency estimates is in the range of several kHz, which is much smaller than the interval of frequency resolutions of a Fourier processor with a similar acoustooptic modulator. Accuracy in the range of a few Hz can be

obtained with application of optimal time processing. Figures 2, references 3 Russian.

#### **Computer Aided Design System of Integrated Circuits "Parom-U" for Personal Computers**

937K0045B Kiev IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA  
in Russian Vol 35 No 9-10, Sept-Oct 92 pp 59-61

[Article by N. F. Mogilenko, V. S. Kostyuk, A. A. Onopriyenko, S. K. Puyda; UDC 621.372.061]

[Abstract] The computer aided design system "PAROM-U" which is intended for teaching students practical skills in designing integrated circuits using personal computers of the IBM PC/AT type is described. The software uses FORTRAN-77 language. The system includes program packages, fully compatible with the input and output data format. The design system consists of seven sub-systems. Functioning of each sub-system is explained. The "PAROM-U" system can be supplied to the country's higher institutes of learning with a set of instructions.

#### **Diacoptic Method for Analysis of Dynamic Modes of Electronic Circuits**

937K0045C Kiev IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA  
in Russian Vol 35 No 9-10, Sept-Oct 92 pp 62-64

[Article by V. V. Zhumik, A. V. Kurganovich; UDC 621.372]

[Abstract] A diacoptic method is discussed. The application of this method allows to fully account for the inertial properties of the circuit's functional points, while the mutual interaction of the sub-circuit is accounted for, using additional hypothetical energy sources connected to the circuit partitioning points. The procedure of numerical integration of the sub-circuit equations specified in the basis of varying states using a linear system is examined. It was demonstrated that for these circuits the proposed method was A-stable, whereas the stability of the standard method strongly depends on the circuit parameters. Figures 2, references 2 Russian.

#### **Modification of the Alternating Projection Method for Bearing Taking of Pulsed Signals**

937K0045D Kiev IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA  
in Russian Vol 35 No 9-10, Sept-Oct 92 pp 65-68

[Article by E. A. Maltsev; UDC 621.396.96]

[Abstract] The development of the method of alternating projections is responsible for a renewed interest in the method of maximum likelihood. A sequential verification of the direction to each source with suppression of other sources, whose directions are not estimated with

the current iteration, constitute the base of this algorithm. A modification of the alternating projection method and the results of experiments demonstrating its application in different signal-noise situations is examined here. It is shown that the application of a signal sub-space for estimating the correlation matrix, where the interfering sources are removed, helps to increase the accuracy of estimating the bearings. References 4: 1 Russian, 3 Western.

**Analytic Computation of Correlation Function of Linear Codes of Digital communication Systems**

*937K0045E Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 35 No 9-10, Sept-Oct 92 pp 69-71*

[Article by M. B. Solodovnichenko, A. G. Zamyatin; UDC 621.396.6:681.7.068]

[Abstract] Among digital data transmission systems, the binary block codes of the type mBnB are the most popular. These codes exhibit many advantages, but the procedure of determining the correlation function of each code can be long. The analytical computation of the correlation function of these codes can be significantly simplified. A method is described for analytical computation of the correlation function of digital signals applicable for block codes of an arbitrary length and construction. The analysis of these relationships indicate that for computation of the correlation function, a matrix of the correlation elements must be determined for each code. A table is provided for comparing the values of the normalized correlation function for different codes, computed analytically by applying the developed method, with the one, obtained by the method of imitation modeling with a computer. A random numbers generator was used for modeling the imitation sequences. Tables 1, references 4: 2 Russian, 2 Western.

**Acoustooptic Microwave Frequency Meter Based on Anomalous Diffraction in  $\text{LiNbO}_3$**

*937K0045F Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 35 No 9-10, Sept-Oct 92 pp 74-78*

[Article by V. V. Rozdobudko; UDC 621.391]

[Abstract] The feasibility is experimentally demonstrated of expanding the operating frequencies band and increasing the efficiency of diffraction in the microwave acoustooptic frequency meters, where both diffraction components are used, while the continuity of the frequency meter operating frequencies is provided by selecting the orientation of the acoustic wave propagation with respect to the optical axis of the crystal, and also by selecting the appropriate length of the piezotransducer in the acoustooptic deflector. A simplified diagram of the examined frequency meter with particular parameters is provided. This frequency meter differs from the familiar meters in that it employs a second set

of optics and a second row of photodetectors, which repeat the diffraction process due to changes in the light direction. Figures 3, references 2 Russian.

**Microelectronic Devices Based on High-Temperature Superconductivity**

*937K0045G Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 35 No 9-10, Sept-Oct 92 pp 3-16*

[Article by Ye. A. Nelin; UDC 621.382.049.77.:538.945]

[Abstract] A review is made of microelectronic devices based on high-temperature superconductors (HTSC) which were developed in 1990-1991. Application of the HTSC films in digital circuits will significantly reduce the time needed for switching, which is inversely proportional to the critical temperature. A common problem for all devices lies in obtaining high quality HTSC films. An unquestionable success has been achieved in solving technological problems of the HTSC application with microelectronic devices. It is projected that in 1992 many of the developed devices will be tested in space. The fundamentals of physical phenomena of the HTSC devices are examined, as well as the technological processes and features of obtaining the HTSC films. The topics of the short review include: frequency-selecting devices, transverse filters, antennas, bolometer, superconducting quantum interferometer devices (SQUID), and digital circuits. There are no theoretical limitations for an extensive application of the HTSC, however, many design and technological problems are still not resolved. The significance of the microelectronic devices based on high-temperature superconductivity in the electronic technology is comparable to the significance of transistors or laser. Figures 12, references 38: Russian 15, Western 23.

**Amplifier Made With Avalanche Transit-Time Diode in the 5 mm Range**

*937K0045H Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 35, No 9-10, Sept-Oct 92 pp 61-64*

[Article by A. R. Barabanov, D. P. Tsarapkin; UDC 621.382.3]

[Abstract] An amplifier is described in the 5 mm range, using an avalanche transit-time diode (ATTD) 2A758V, with 8 dB gain and transmission band of about 1 percent at 1 dB level, operating in the small input power mode. The amplifier consists of a radial resonator, operating on the first harmonic, with an avalanche transit-time diode located in the center of the axial symmetry. It was demonstrated that at identical load impedances, the radial oscillating system exhibits advantages, in terms of range properties, over a rectangular waveguide. Amplitude-frequency characteristics (AFC) of the amplifier for different input powers were obtained. These data indicates that the distortions of the AFC due to variations in

the ATTD input power can be compensated by changing the value of the ATTD power supply. An previously unknown instability of the ATTD 2A758V was detected during the tests of the diode's voltage behavior, manifested in generation of low-frequency oscillations in a narrow range of the power supply currents. Figure 3, references 4: 2 Russian, 2 Western.

#### Expanded-Region Method for Problems of Excitation of Planar Conductors With Noncoordinate Surface Shapes

937K0036A Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 8, Aug 92  
(manuscript received 25 Nov 90) pp 1345-1351

[Article by Ye.A. Konyashenko and A.Ye. Solovey; UDC 621.396.7]

[Abstract] The expanded-region method used for designing waveguides of intricate configuration (V.V. Nikolskiy; RADIOTEKHNIKA I ELEKTRONIKA, Vol 9 No 4, Apr 64) and strip line radiators (Ye.A. Konyashenko, et al.; RADIOTEKHNIKA I ELEKTRONIKA, Vol 28 No 3, Mar 83) is extended to planar radiators with a noncoordinate shape of the surface contour. This method yields the radiator characteristics directly, without a prior solution of the given boundary-value problem. First is considered an ideally conducting plane aperture with such a surface and the boundary condition  $E_+ E_t = 0$  ( $E$  - tangential vector component of electric field of current flowing in the aperture,  $E_t$  - tangential vector component of exciting electric field). For solution of the excitation problem by this method, the shape of the expanded region is selected so that it not only covers a rather large class of intricately shaped apertures but also that its impedance operator have "good" analytical properties and can be readily evaluated. As a model of a plane radiator is selected an axisymmetric one whose width  $w$  varies as an arbitrary even function of its longitudinal coordinate  $l$ , a rectangle of width  $W$  and length  $L$  being selected as the expanded region for solution of the model excitation problem. The algorithms were programmed in FORTRAN on an IBM personal computer, calculations having been necessarily limited to radiators with dimensions  $l/L > 1/3$  and  $w/W > 1/6$  only. The wave impedance of the feeder matched to a radiator at its maximum width was found to be an approximately universal function of the ratio  $L/W^*$  ( $W^*$  - characteristic transverse dimension of radiator, determined by its width within the excitation zone). An analysis of the results indicates that the widest frequency band of 2-3 octaves within which such a radiator and the feeder can be adequately matched, with a voltage standing-wave ratio  $VSWR < 2$ , is attainable by use of a radiator whose length-to-width ratio within the 2-3 range and with a clearance not wider than one tenth of the radiator length. It is shown that the matching can be further improved by

departure from a rectangular shape of the radiator within the same frame dimensions. The efficiency of the expanded-region method is comparable with that of the spectral methods and its universality approaches that of the finite-elements method. Figures 2; references 10.

#### Scattering of Electromagnetic Waves by Metal Disk

937K0036B Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 37 No 8, Aug 92  
(manuscript received 4 Mar 91) 1351-1358

[Article by S.M. Nesterov and I.A. Skorodumov; UDC 621.372.8.01]

[Abstract] Scattering of electromagnetic waves by a metal disk is considered, the problem being evaluation of the oblate spheroidal functions of the argument  $C$  over the  $0 < C = ka \leq 80$  range for subsequent numerical calculation of both components of the scattered electromagnetic field and the effective scattering area of the disk surface. The necessary relations are derived for incidence at an arbitrary angle of an arbitrarily polarized plane electromagnetic wave on a disk having a diameter equal to 25 wavelengths. The scattered field is calculated in a spherical system of coordinates  $g$  (radius -vector of observation point),  $\theta, \Phi$ . The polarization of the incident wave is defined by the angle of its plane of incidence relative to the  $+\Phi$  direction so that  $\alpha = 0$  and  $\alpha = 90^\circ$  correspond to  $\theta$ -polarization in a plane parallel to the  $E$ -plane and  $\Phi$ -polarization in a plane parallel to the  $H$ -plane respectively. The oblate spheroidal functions are, as usually, expanded into Legendre polynomials satisfying a trinomial recurrence equation where  $-jC$  appears with either of four different coefficients:  $d(mn)_{r+2}, d(mn)_{r-2}, d(mn)_r, d(mn)_{r+1}, \lambda_{mn}$ , in addition to either of the known three other coefficients  $\beta(m)_r, \gamma(m)_r, \epsilon(m)_r$  ( $\lambda_{mn}$  - eigenvalues). This equation, upon integration, yields two different expressions representing the ratio of coefficients  $d(mn)_r/d(mn)_{r+1}$ , one as the difference between two finite products of fractions and one as a fraction equal to an infinite product of fractions. These two expressions are equivalent analytically but not in the sense of numerical evaluation, because their evaluation by the iterative process leads to different errors. Equating them yields nevertheless a system of  $r \geq 0$  analogous equations for the eigenvalues  $\lambda_{mn}$  with  $m$  fixed, each equation including an infinite product of fractions on the left-hand side. The indeterminacy involved in determining the best number  $r^*$  for calculation of these eigenvalues is removed by truncation of the infinite product and interpolation of the remainder on the left-hand side with a polynomial of the  $k$ -th degree, where  $k = r^*/2 + 1 + 1$  ( $l$  - order of the residual fraction) so that each of the  $r^*$  truncated equations can be rewritten in the form  $P_k \lambda_{mn} / Q_{k-1}(\gamma) = 0$ . This system of  $r^*$  equations is solvable with high precision by the Mueller-Lans iteration method. In this way has been evaluated not only the dependence of the effective scattering area of a metal disk (normalized to  $\pi a^2$ ) but also its

dependence on the observation angle  $\theta$  for a metal disk with the dimension  $ka = 40$  and either E-polarized or H-polarized plane waves arriving at various angles of incidence  $\theta_0$ . Figures 5; references 8.

### Scattering of Magnetostatic Waves in Stationary Periodic-in-Space Magnetic Field

937K0036C Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 37 No 8, Aug 92  
(manuscript received 28 Nov 91) pp 1371-1380

[Article by A.Yu. Annenkov, S.V. Gerus, and I.V. Sotnikov; UDC 537.624.2]

[Abstract] An experimental study of magnetostatic waves propagating through channels formed in ferrite films by a parallel stationary periodic-in-space magnetic field (magnetic grating) was made, this magnetic field being superposed on a much stronger uniform one. Specimens of YIG (Y-Fe garnet) single-crystal films for this study were grown by liquid-phase epitaxy on GGG (Ga-Gd garnet) single-crystal substrates, the plane of these 6-14  $\mu\text{m}$  thick films coinciding with the crystallographic (111) plane. The source of the magnetic grating was a 16  $\mu\text{m}$  thick high-coercivity ( $H_c \approx 1000$  Oe) magnetic tape carrying a sinusoidal signal. The space period of the signal was varied over the 50-1000  $\mu\text{m}$  range and the amplitude of the periodic-in-space magnetic field reached 75 Oe. Both input and output microwave transducers were gold-coated tungsten wires, 15  $\mu\text{m}$  in diameter and 4 mm long each, designed for generating and receiving 150-3000  $\mu\text{m}$  long magnetostatic waves. They were pressed against the tape and thus placed in the field of the magnetic grating, the tape in turn having been glued to the ferrite film. Measurements made during the tests have yielded data on interaction of volume and surface magnetostatic waves with a magnetic grating, also the amplitude-frequency characteristic of the experimental multilayer structure as well as the dispersion relations corresponding to its first and second passbands for both kinds of magnetostatic waves. The results reveal a shifting of the spectrum of surface magnetostatic waves toward higher frequencies as the amplitude of the magnetic grating increases. They also reveal a cutoff of long-wave surface magnetostatic waves, the cutoff wavelength depending on both amplitude and space period of the magnetic field. The results of this experimental study are interpreted theoretically on the basis of the Damon-Eshbach boundary-value problem for the scalar potential of a high-frequency magnetic field (J. PHYS. CHEM. SOLIDS; Vol 19 Nos 3-4, 1961). Prior to solution of this problem is first solved the static problem for a stationary periodic-in-space magnetic field acting on a YIG film. Figures 5; references 5.

### Energy Losses in Antenna With Capacitive Shell

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ELEKTRONIKA in Russian Vol 37 No 8, Aug 92  
(manuscript received 22 Nov 90, corrected version  
received 1 Oct 91) pp 1381-1388

[Article by V.I. Fedyanovich and A.V. Provotorov; UDC 621.396.67.01]

[Abstract] A small antenna in the form of a spherical hollow cavity resonator, a semitransparent thin spherical dielectric shell coated inside and outside with periodic arrays of identical metal strip segments is considered. The two arrays have been symmetrically shifted relative to each other so that the shell becomes an array of either parallel or crossing capacitor chains. Such an antenna is ideally excited by having each capacitor connected across its current generator, the amplitude of the current being proportional to the electric field intensity at the capacitor location so that forced oscillation relative to the field distribution will coincide with its free oscillation. The design problem is to determine the dimensions of those strip segments to match a given resonance frequency when the shell dimensions and the permittivity of the dielectric layer material are given. This problem has more than one solution. For a performance analysis, therefore, the dielectric permittivity is sought when the dimensions of the strip segments and their configuration are given. The energy losses in such an antenna are accounted for by including them in the averaged boundary conditions. On this basis are then, by the standard method of field theory, calculated the antenna performance parameters: efficiency, gain, Q-factor, and bandwidth. The program SHELL has been written for numerical analysis aimed at design optimization, which includes matching the necessary permittivity with a dielectric material. Figures 4; tables 2; references 9.

### Impedance Method of Analysis of Polarization Losses in Antenna Arrays

937K0036E Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 37 No 8, Aug 92  
(manuscript received 18 Jan 91) pp 1388-1395

[Article by P.L. Tokarskiy; UDC 621.396.67.095.1]

[Abstract] The polarization losses in an antenna array with a finite number  $N$  of transversely excited elements are calculated by the impedance method. Assuming that the radiation pattern of each of the elements excited alone is known, their vector radiation patterns are resolved into the sum of their respective unit vector  $b^0$  and unit vector  $c^0$  components. In an orthogonal polarization basis the expression for the corresponding matrix  $r_\Sigma$  of normalized self and mutual radiation resistances reduces to the sum of its  $bb$  and  $cc$  self-resistance elements, which in turn yield corresponding expressions for the radiation power and the polarization loss factor. The electrodynamic problem of calculating the vector radiation patterns of the antenna elements is subsequently solved upon transformation of the polarization basis to a linear one in a spherical system of coordinates. The polarized-radiation resistances in four different arrays of two identical electric Hertz dipoles (both vertical and parallel, both horizontal and parallel in same horizontal plane, both horizontal and parallel one above the other in same vertical plane, at right angles one above the other in two different horizontal planes) are then described in the classical representation. This representation is then, upon the appropriate polarization basis transformation, applied to a phased array of turnstile antennas consisting of two orthogonally crossed dipoles each and together radiating a circularly polarized field. An analysis and numerical calculations reveal that the

polarization loss factor is much smaller when such an antenna is located above a passive horizontal shield than when such an antenna is located a quarter-wavelength distance above an active reflector in the form of an identical other antenna. Figures 4; references 8.

### Nonlinear Theory of Dielectric Wideband Amplifier in Electron Beam Device

937K0036F Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 37 No 8, Aug 92  
(manuscript received 9 Jul 91) pp 1490-1497

[Article by A.F. Aleksandrov, M.V. Kuzlev, V.A. Panin, and A.P. Plotnikov; UDC 533.537.5]

[Abstract] A nonlinear theory of a dielectric retarding structure acting as a wideband amplifier of electromagnetic waves in a high-current electron-beam device is constructed, considering that the Cerenkov resonance line  $\omega = k_1 u$  in the  $\omega, k_1$  plane for such waves with high longitudinal wave numbers in a dielectric waveguide does almost coincide with the wide dispersion curve for such a waveguide when their phase velocity is lower than the speed of light and very close to the velocity  $u$  of the quiescent electron beam. The theory is formulated as a boundary-value problem for two wave equations in Lagrangian time-velocity coordinates with the transverse part of the Laplace operator in one of them and with the Hertz polarization potential, proportional to the transverse component of the electric field of the input signal, in both of them. The problem, actually a three-dimensional one when the transverse field structure and polarization distortions in the waveguide are accounted for, is reduced to a system of two dimensionless nonlinear equations which describe amplification of a wideband signal in a dielectric waveguide. The signal frequency band is defined by the relation as  $\omega_s = s\omega_0$ , where the parameter  $s$  ranging from  $s_{\min}$  to  $s_{\max}$ . Solution of this system of equations is facilitated by considering a dielectric half-space not laterally bounded by the electron beam. Its prior solution in the linear approximation and then for low-current electron beams is followed by its solution for medium-current and then high-current electron beams, the current strength being defined by the dimensionless parameter  $\mu = I_b/I_0)^{1/3}$  ( $I_b$  - actual beam current,  $I_0$  - current of beam propagating through vacuum so that  $\mu_{\max} = 1$ ). Analytical expressions are derived for the performance characteristics of the dielectric amplifier: its amplification band in the  $(\mu, s)$  plane, its  $s$  - dependent gain and efficiency, successive frequency ( $s$ ) spectra of the transverse field along the dielectric structure, and the frequency deviation from resonance. Numerical estimates based on a beam current of 29 kA with  $\mu \approx 1$  and  $u \ll c$  in a dielectric waveguide with an initial relative permittivity  $\epsilon_0 = 2.8$  have yielded a beam power of about 14.8 GW an amplifier output power of about 1.8 GW total output power, which corresponds to a maximum efficiency close to 12 percent. Figures 2; references 15.

### Effect of Strong Retarding Potentials on Transmission Characteristics of Polytron

937K0036G Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 37 No 8, Aug 92  
(manuscript received 27 May 91) pp 1503-1508

[Article by Ye.Yu. Gladkov and N.E. Gvozdikova; UDC 621.385.69.01]

[Abstract] The transmission characteristics of a polytron with a nonrelativistic electron beam in vacuum and with a retarding structure are analyzed for the effect of electron scattering and the possibilities of beam polarization. An array of function plates is inserted between the pair of scanning plates and the collector so that the number of beam electrons reaching the collector surface is modulated according to the form of this array, the form of this array then also being portrayed by the  $I_c - V_s$  characteristic ( $I_c$  - collector emission current,  $V_s$  - potential difference between the two scanning plates). A pair of correcting plates with a potential difference  $V_r$  between them ensures scattering of beam electrons by the outside surface of the collector. The mathematical model for theoretical calculation of the  $I_c - V_s$  phase portraits is an elliptical electron distribution  $(x - \alpha)^2/c^2 - (y - \beta)^2/d^2 = 1$  in a beam compressed by the negative potential difference between the scanning plates ( $\alpha, \beta$  denoting the coordinates of the center of mass in the Cartesian system of  $x, y$  coordinates,  $d/c$  denoting the beam compression factor). While the coordinates  $\alpha$  and  $\beta$  are linear functions of the potential differences  $V_s$  and  $V_r$  respectively, the ratio  $d/c$  depends on the potential distributions of the electric fields of the scanning plates and the correcting plates in the region of anode and second-anode electrodes. Inasmuch as the description of scattering in a polytron does not need to be refined to the quantum level, the problem is simplified by describing the collector current in the plane geometrical optics representation, with inclusion of the secondary-emission coefficient as an approximately constant quantity within the range of small incidence angles. Not only the dependence of the compression factor  $d/c$  and of the collector current but also of the beam current density on the static potential difference  $V_x$  between the scanning plates in the electron-gun mode is considered, the electric field in this mode forming a pair two immersion lenses in the region of scanning plates and second-anode electrodes: a focusing one before the entrance to and a defocusing one behind the exit from the scanning plates. In an experiment with the LF9P polytron the voltage  $V_s$  was varied from 0 (electron gun) to 25 V and its frequency over the 20-60 Hz range, the voltage  $V_r$  was held constant at 20-30 V levels, and the voltage  $V_x$  was held constant at various levels from zero 0 (electron gun) up. The results confirm the theoretically predicted strong effect of retarding potentials and beam polarization on the transmission characteristics of this device, conditions being evidently attainable which will make the degree of beam polarization linearly dependent on the potential of the scanning plates. Figures 3; references 6.

**Developments in the Area of Communications by the Scientific Research Institute for Railroad Automation**

937K0072A Moscow AVTOMATIKA  
TELEMEKHANIKA I SVYAZ in Russian No 10,  
Oct 92 pp 2-4

[Article by I. D. Blinder; UDC 656.254.54:621.395.65]

[Abstract] The modernization of communication equipment which was carried out by the Scientific Research Institute for Railroad Automation during the past several years is discussed. Among others, the following equipment was developed or modernized: commutators for operational and engineering service communication of railroad stations; communication sections SPM-KTS for organization of operational and engineering communication of the station's traffic controllers, input protection devices for protection of service personnel and all communication equipment from hazardous voltages at junctions and station's, public address systems and loudspeaker communication equipment for small station yards. Equipment for railroad stations two-way yard communication was also modernized. This modernization, which was conducted in 1990, consisted of replacing the 100 VA feeder amplifiers in the distribution-amplification desk by 200 VA amplifiers. The second stage of the equipment modernization is scheduled for 1992.

**Improving the Performance of Rail Circuits Under Conditions of Interfering AC Traction**

937K0072B Moscow AVTOMATIKA  
TELEMEKHANIKA I SVYAZ in Russian No 10,  
Oct 92 pp 7-8

[Article by N. N. Guk, V. S. Lazarchuk, V. I. Tsygankov;  
UDC 656.259.12:621.3.025]

[Abstract] Because of heavy and many-wagon train traffic which has been introduced in some sections of railroads powered by AC, the interfering effects of reverse traction current on the rail circuit equipment are increased. Measurements conducted on West-Siberian and East-Siberian railroads demonstrated that in some cases, the asymmetry current in the choke-transformer DT-150 was 70-80 A, while the normal is 15 A. This causes significant distortions in the road filter FP-25 of code and protection unit ZB DSSH of the rail circuit. The standard coded rail circuit was tested under laboratory conditions for quantitative and qualitative estimates of the recorded phenomenon. The tests demonstrated a presence of a significant level of distortions generated in the rail circuit equipment with increased asymmetry. Causes, and measures for their elimination are discussed. A modernized protection unit ZD DSSH-M was developed to improve the protecting properties of the existing unit.

**Application of the IKM-120 Communication System at Operating Railroad Cable Mainlines**

937K0072C Moscow AVTOMATIKA  
TELEMEKHANIKA I SVYAZ in Russian No 10,  
Oct 92 pp 21-25

[Article by V. Ye. Vinokurov, V. V. Vinogradov, V. K. Kotov; UDC 656.254.153:621.376.56]

[Abstract] In the past, systems of railroad automation and telemetry have been developed without regard to electromagnetic compatibility (EC) with digital transmission systems. The problem of providing EC of linear paths of pulse code modulation system IKM-120 with other circuits in a common cable can be solved by application of organization-engineering, system-engineering and circuit-engineering methods. Measures are discussed that can be taken to eliminate or to reduce the electromagnetic effects. These methods include addition of noise suppressing cells in the circuits containing power sources; addition of varistors; installation of low-frequency filters at the outputs of the units supplying power to the automatic lock-out circuits. The efficiency of these methods for protection of the IKM-120 transmission system was experimentally tested, and it was concluded that employment of the existing two-cable trunks for communication using the IKM-120 system is impossible without special protection measures from pulsed noise produced by linear automatic lock-out circuits and also by the operation and engineering communication circuits and the subscriber's lines. The recommended engineering solutions will make it possible to organize the operation of the IKM-120 in a common cable with other lines.

**Changes in the Signalling Device Activation Circuit**

937K0072D Moscow AVTOMATIKA  
TELEMEKHANIKA I SVYAZ in Russian No 10,  
Oct 92 p 30

[Article by P. P. Gryaznov]

[Abstract] When the feeders are being switched (short-time disconnect of power), the grounding indicators of the Sz-2U4, Sz-1U4, Sz-3U4 type signalling and interlocking devices disconnect the control of insulation of all electric circuits. All magnetic amplifiers are opened, the KR relay is triggered, current in the VR relay is interrupted and the alarm signalling system is activated. To disconnect the alarm system and to connect the controlled electric circuits, switches V1 - V6 must be for a short time switched to position "Zaryad". Because of this, Sz-1U4 type indicators are not connected at many electric centralization (ETs) stations which have no on duty attendance of electricians. In order to automatically restore the indicator's functioning when switching the feeders, it was proposed to change the indicator's circuit. A block diagram of the proposed circuit is provided, and its operation is briefly discussed.

### Unconventional Economical Induction Motor Designs for Production by Classical Technology

937K0040A Moscow ELEKTROTEKHNIKA in Russian  
No 8-9, Aug-Sep 92 (manuscript received 13 Dec 91)  
pp 11-14

[Article by A.A. Stavinskiy, candidate of technical sciences, Central Scientific Research and Design Institute "Tayfun"; UDC 621.313.333.042.14.001.6]

[Abstract] A new induction motor design has been patented by the author (USSR Certificate No 1,339,749; OTKRYTIYA I IZOBREtenIYA, No 35, 1987) which combines modern steel economy requirements and compatibility with classical production technology designed to minimize waste of steel. The magnetic stator structure is formed by multiplanar spatial steel laminations inside an octagonal frame. These laminations form flat teeth and the annular yoke part of core, also core tabs bent at a 60° angle from the plane with a corner radius each. The laminations are each rotated through a 90° angle relative to the preceding one so that they form a "helical" stack, with the tabs of each between the edges of the adjacent one on both sides. Such a construction ensures mutual compensation of parasitic e.m.f.'s, forces, and torques arising due to periodicity of yoke height variation. The second design feature is inclusion of clearances between flat edges and bent tabs of adjacent laminations which, while necessary for the manufacturing process, contribute to the redistribution of the magnetic lines of force fringing from the edges of laminations to the root segments of tabs so that the distribution of the magnetic field in the yoke becomes more uniform and its harmonic content in the air gap becomes more favorable. The third design feature is a larger outside core surface available for heat dissipation. A complete design analysis including that of the rotor structure patented by A.A. Stavinskiy and N.A. Shcherbakova (USSR Certificate No 663,024; OTKRYTIYA I IZOBREtenIYA, No 18, 1979) has been applied to production of high-efficiency 2-pole induction motors with a 50 mm shaft height, both frame and stepped shaft being made of corrosion-resistant steel, also to production of standardized with them frameless single-phase induction motors. Figures 2; references 6.

### Noiseless Bearings and Plastic Lubricants for Electric Machines in Accordance With Vibroacoustic Requirements

937K0040B Moscow ELEKTROTEKHNIKA in Russian  
No 8-9, Aug-Sep 92 (manuscript received 22 Oct 91)  
pp 17-21

[Article by V.A. Voronkin, candidate of technical sciences, and V.V. Yevlanov, engineer; UDC 621.313.3:539.4]

[Abstract] Noiseless roller bearings with plastic lubricants for electric machines operating on ships were tested in accordance with a new procedure conforming with the latest vibroacoustic noise level 4 requirements.

They were tested in 15 kW machines under radial loads but not at frequencies covering the 31.3-10,000 Hz range, as were grade Sh7-Sh6 (noise levels 7-6) bearings, but specifically at 125-1000 Hz and 2000 Hz frequencies. Those passing these tests have been designated as grade Sh4 bearings and the data used for guidance in development of grade Sh3 bearings. They were tested with conventional lubricants featuring a long life expectancy and with three new vibration-damping lubricants: lithium-base grade VIIIP-242 (Scientific Research Institute of Petroleum Reprocessing), lithium-base SVEM modification of SEM grade (Scientific Research Institute of Electromechanics; S - lubricant, EM - electromechanical grade), calcium-base grade TsIATIM-221 (Scientific Research Institute of Aviation Fuels and Lubricants). The grade SVEM having been selected as the most suitable lubricant, it was further modified for optimum overall performance. Addition of modifiers to the SEM lubricant was, however, found to degrade its vibroacoustic characteristics. These characteristics can, evidently, be improved by not simultaneously requiring maximum possible load capacity. Guidelines for further development and introduction of noiseless roller bearings are proposed which take into account the economic factors as well, most importantly ensuring a long retention of low vibration levels so as to avoid replacement. Formalization of already attained performance levels in terms of guarantees is recommended, considering that eventually roller bearings will have to cease to be the "wild card" they are now and will have to satisfy technical specifications consistent with those applied to the electric machine as an integral unit. Figures 7; tables 4; references 7.

### Evaluation of Contribution of Loads to Degradation of Electrical Energy

937K0093A Moscow ELEKTRICHESTVO in Russian  
No 11, Nov 92 (manuscript received 20 May 91)  
pp 13-19

[Article by F.A. Zykin]

[Abstract] Degradation of the quality of electrical energy in terms of voltage and current waveform distortions in a power system is considered, determining the degradation due to users' distorting loads being a major problem in the design of new rate schedules. Existing theoretical methods of estimating the load-contributed part of that degradation are not necessarily valid and can yield erroneous estimates, as is the case with the common quantitative definition of the "load liability for degradation" factor as the ratio  $b = (Q_{on} - Q_{off})/Q_{on}$  ( $Q_{on}$ ,  $Q_{off}$  - values of some quality indicator with load disconnected and with load connected respectively). Wrong use of this load liability factor is demonstrated on three asymmetric loads giving rise to three negative-sequence currents and to three asymmetric voltages: According to this definition, erroneously none of the three loads would appear to be causing distortions. In the case of a two symmetric 3-phase "delta" loads made asymmetric by disconnection of one phase in one or in both the thus defined load

liability factor would, depending on which phases have been disconnected, lead to three different results including two absurd ones for the three different combinations of loads under consideration. A more valid definition of the load liability factor, based on the distribution of energy among loads, is therefore proposed and its application demonstrated on a 3-phase system with a neutral line. Calculations made for six different combinations of loads with the aid of equivalent circuit diagrams, including one for anomalous components of currents in the power system, indicate that the thus defined load liability factor depends on individual active and reactive components of secondary power at the load terminals and in the power generating system, this having been confirmed by field tests and measurements. Because the secondary power and consequently the thus defined load liability factor not only vary in time but can even reverse sign, it is most expedient to consider specific periods of time for calculation of thus defined load liability factor and to estimate the load conditions during any such period on the basis of integral criteria which can be readily evaluated by statistical methods. Figures 5; tables 2; references 4.

#### Electromagnetic Field of Two-Conductor Line

937K0093B Moscow ELEKTRICHESTVO in Russian  
No 11, Nov 92 (manuscript received 5 Feb 92) pp 43-47

[Article by Ya.N. Kolli, candidate of technical sciences, Moscow Institute of Power Engineering]

[Abstract] The electromagnetic field and the impedance per unit length of two parallel circular current-carrying conductors of the same size are calculated by the Fradkin method (B.M. Fradkin; ELEKTRICHESTVO, No 6, Jun 91), both conductors carrying the same sinusoidal current but in opposite directions  $+I$  and  $-I$  respectively. The magnetic field components inside and outside the conductors are expressed in the form of appropriate series involving the vector potential  $A_n$  with  $\cos(n\alpha)J_n'(pp)$  (inside) or  $\cos(n\alpha)$  only (outside), in a polar system of radius  $r_{1,2}$  and angle  $\alpha_{1,2}$  coordinates in a cross-section plane with the origins  $O_{1,2}$  at the centers of conductors 1,2 respectively. Impedances are expressed in the complex form  $Z = pe^{j\alpha}$ . The boundary conditions at the surface of each conductor are equal vector potentials and equal tangential components of the magnetic field. An analytical solution of the problem, which involves a Fourier series expansion of the vector potentials and appropriate subsequent substitutions, is followed by a numerical solution which has been programmed in FORTRAN on an IBM personal computer. Calculations have been made for conductors with a radius  $r_0 = 5.4$  cm made of a material with an electrical conductivity  $\sigma = 50$  kS/cm and carrying a current which alternates at the 50 Hz frequency, the center-to-center distance  $2a$  between conductors being varied over the 5.4-29.70 cm range and the azimuth angle of points in the cross-section plane being varied over the 0-180° range. The accuracy of calculations increased rapidly as more terms of the series were being included. The results indicate that the proximity

effect in this case ceases to be significant at distances  $2a > 7r_0$ . Figures 1; tables 2; references 2.

#### Harmonics in 3-Phase Networks

937K0093C Moscow ELEKTRICHESTVO in Russian  
No 11, Nov 92 (manuscript received 3 Jun 91) pp 53-54

[Article by I.V. Karpov, candidate of technical sciences, Kiev]

[Abstract] In consideration of the growing use of devices with nonlinear elements in Y-Y 3-phase networks, the harmonic content of the currents in such systems is evaluated by first expanding each of the three nonsinusoidal phase currents into a Fourier series and then resolving each harmonic into symmetrical components. In the neutral line, when included, there will flow only the zero-sequence components and without a neutral line all the zero-sequence components vanish. This procedure is preferred over conventional ones generally based on erroneous assumptions. One erroneous assumption is that no third-harmonic currents can flow in 3-phase networks without a neutral line. Another erroneous later assumption is that fifth, eleventh, seventeenth, ... harmonics form each a negative-sequence component and first, seventh, thirteenth, ... harmonics form each a positive-sequence component. The reverse procedure of first resolving nonsinusoidal phase currents into symmetrical components and then expanding each component into a Fourier series is also incorrect, which has been demonstrated by an experiment involving measurement of currents in a 10 kV 3-phase network without neutral line and their subsequent harmonic analysis. Even harmonics not being of concern here, odd harmonics from third to seventeenth in Y-Y networks with a neutral line and Y-Y networks without a neutral line are evaluated by the author's procedure in terms of phase angle and relative amplitude (numerical amplitude of first harmonic being 100). The current in the neutral line is shown to contain all odd harmonics and not, as has also been erroneously assumed, only the third and its multiples. An interesting application of this method of harmonic analysis is in locating phase-to-ground faults along 6-20 kV overhead power transmission lines with the aid "Volna" (Wave) instruments responding to the magnetic field of the zero-sequence component of the eleventh phase-currents harmonic. Tables 1; references 5.

#### Method of Calculating Allowable Continuous Current in Self-Supporting Insulated Conductors

937K0085A Moscow ELEKTRICHESTVO in Russian  
No 10, Oct 92 (manuscript received 11 Sep 91) pp 5-8

[Article by A.M. Ayzen and A.S. Vyskirk]

[Abstract] Use of self-supporting insulated conductors promises to make 380 V overhead electric power transmission lines not only more reliable but also safer,

such a conductor consisting of three phase strands insulated with light-proof black polyethylene and twisted around a bare neutral strand which carries the mechanical load. The key design problem is to establish the maximum allowable continuous load current these conductors can carry, this limit being determined by the thermal stability of the insulation material. Neither the standard equations for power cables nor the equations of heat balance are applicable here, inasmuch as overhead conductors have no shield and the the radial temperature distribution in them changes. For calculating that allowable continuous current is, therefore, proposed a mathematical model which describes steady-state heat conduction in any cross-section of a sufficiently long solitary isolated conductor segment with ideal thermal contact between copper and insulation. The model consists of two one-dimensional second-order differential equations of the parabolic kind, one for the copper with  $A = \rho j(1 + \varepsilon t_{Cu} k / \kappa)$  ( $\rho$  - electrical resistivity of copper,  $\kappa$  - thermal conductivity of copper,  $j$  - current density in conductor,  $t_{Cu}$  - temperature of copper,  $\varepsilon$  - constant,  $k$  - coefficient representing additional losses) on the right-hand side and one for the insulation with 0 on the right-hand side. There are two boundary conditions stipulated at the copper-insulation interface and one boundary condition stipulated at the outside insulation surface. The peculiar feature of this boundary-value problem is the constant coefficient  $\varepsilon$  serving as the small parameter when the temperature varies over a range typical for overhead transmission lines. The two equations are refined to take into account incident solar radiation as well as radiative and convective heat transfers from conductor to ambient air, also wind velocity up to 0.6 m/s. The dependence of the current capacity on the solar heat load covering the 0-2000 W/m<sup>2</sup> range is evaluated in accordance with standard formulas ( $\varepsilon = 0.004/K$ , maximum allowable insulation temperature 70°C, ambient air temperature 20°C, wind velocity 0.6 m/s) for conductor cross-sections covering the 16-120 mm<sup>2</sup> range, the current capacity under any given solar heat load being higher for conductors with larger cross-section. The current capacity of SASP conductors produced in Russia and AMKA conductors produced by NOKIA in Finland has been evaluated by this method on the basis of 90°C maximum allowable insulation temperature, 25°C ambient air temperature, and 2000 W/ mm<sup>2</sup> solar heat load. Figures 2; tables 2; references 13.

#### Transient Electromagnetic and Thermal Processes in Cylindrical Conductors Struck by Lightning Current Pulse

937K0085B Moscow ELEKTRICHESTVO in Russian  
No 10, Oct 92 (manuscript received 28 Nov 91) pp 9-15

[Article by M.I. Baranov and N.N. Bondina]

[Abstract] Transient electromagnetic and thermal processes taking place in nonmagnetic solid and hollow circular cylindrical conductors struck by a lightning current pulse are analyzed, the problem being formulated for conductors with very large length-to-diameter

ratios in air. The nonferrous conductor material is characterized by its electrical resistivity, thermal conductivity, and a volumetric specific heat. The conductor current during the main lightning discharge is assumed to have the form  $i_M(t) = \beta[\exp(-\alpha_1 t) - \exp(-\alpha_2 t)]$  ( $i$  - dimensionless current normalized to amplitude of lightning current pulse,  $t$  - dimensionless time normalized to period of allowable temperature rise) and to flow along the conductor axis. Compression of the conductor as well as phase transitions such as melting and evaporation of its material are disregarded so that its electrical conductivity in the solid state depends on its heat content only and its thermal conductivity depends on its temperature only. The radial distributions of electromagnetic field and temperature during the transient period are described by a system of two one-dimensional second-order differential equations of the parabolic kind, with Fourier and Newton boundary conditions at the conductor surface in air. This system of equations and boundary conditions is reduced to a dimensionless form with inclusion of both Fourier and Biot numbers, then converted into a system of two dimensionless difference equations with corresponding but simplified boundary conditions for a numerical solution. Calculations were made for current pulses of amplitudes approaching 1 MA and durations approaching 1 ms during the main lightning discharge in copper conductors (99.5 percent pure electrolytic), aluminum conductors (99.5 percent pure annealed), and stainless steel conductors (AISI 304). The results indicate that neither cooling of such conductors by a high-velocity air stream nor heat conduction in them play a significant role during the transient period. They also indicate that lightning current pulses of up to 300 kA amplitude and 2-50  $\mu$ s duration can melt large thin tubular copper and aluminum conductors during the main lightning discharge, with attendant surface erosion which facilitates electrical explosion of the skin-effect layer. Figures 6; tables 1; references 17.

#### Anomalous Shielding of Magnetostatic and Electrostatic Fields

937K0085C Moscow ELEKTRICHESTVO in Russian  
No 10, Oct 92 (manuscript received 26 Mar 91)  
pp 21-35

[Article by A.D. Roninson, doctor of technical sciences, Tallinn Technical University]

[Abstract] Anomalous as well as normal shielding of magnetostatic and electrostatic fields is analyzed, shells made of a ferromagnetic material being used for shielding magnetostatic fields and shells made of a dielectric or ferroelectric material being used for shielding electrostatic fields. Mathematical analysis of the shielding problem is based on the Laplace equation for the field potential, this equation being solved by integration for specific shapes of shell and corresponding boundary conditions in an external field assumed to be uniform. First are considered symmetric spherical shells and infinitely long axisymmetric circular cylindrical ones. When the shell is polarized, then the external field

is shown to induce in the cavity an opposing field so that the cavity becomes shielded. With both a spherical shell and an infinitely long circular cylindrical one regarded as extreme forms of an elliptic spheroidal one with the ratio of semiaxes  $a/b = 1$  and  $a/b = \infty$  (oblate) or 0 (prolate) respectively, the shielding problem is also solved for ellipsoidal shells covering the of  $0 < a/b < 1$  range. In a magnetostatic field the outside surface of a shell provides the shielding effect while its inside surface weakens it. The magnitudes of the two opposing effects depend on the magnetic permeability of the shell material,  $\mu_c$  being designated as the critical magnetic permeability which renders the two effects and higher than that magnetic permeability being needed for shielding. This critical magnetic permeability is calculated for ellipsoidal shells with  $a/b = 2, 5, 10$  ratios in a magnetostatic field in vacuum ( $\mu_0 = \epsilon_0 = 1$ ) or air (paramagnetic with  $\mu = 1.0000038$ ). There is an analogous critical dielectric permittivity  $\epsilon_c$  for shells in an electrostatic field. Inasmuch as  $1 < \mu_c, \epsilon_c < 2$ , anomalous shielding is shown to be possible. While theoretically strengthening of the field in the cavity of a shell is possible but negligible when  $\mu < \mu_c$  and  $\epsilon < \epsilon_c$ , the permeability of ferromagnetic materials being  $\mu \geq 100$  and the permittivity of solid dielectric materials being  $\epsilon \geq 2$  makes strengthening of the field in the cavity impossible. A shell made of a diamagnetic material ( $\mu < 1$ ) always shields the cavity from an external magnetostatic field. A comprehensive analysis of normal and anomalous shielding by shells made of ferromagnetic or dielectric materials is followed by consideration of a nonuniform external field. Normal shielding of its space harmonics and especially of the even ones is much more effective than normal shielding of its fundamental component, by shells with the same permeability or permittivity. Only the third space harmonic of such a field can be anomalously shielded and, besides, only less effectively than the fundamental component. Inasmuch as normal shielding of a nonuniform field is thus more effective and its anomalous shielding less effective than respective shielding of a uniform field, a shielding shell can serve as a filter of space harmonics. The analysis is subsequently extended to shells of arbitrary shape, in which case one can either replace the real shell with the most closely approximating it equivalent regular smooth one, or expand the field potential due to polarization of the shell into an infinite series of harmonic functions of coordinates in the system of coordinates in which one of the coordinate surfaces most closely approximates that of the real shell. An important practical problem are microinclusions and microcracks in shells which not only make a shell asymmetric but may also raise the electric field intensity in the cavity and thus facilitate breakdown of the insulation. With regard to variable in time rather than static or quasi-static external magnetic fields, it is noted that the eddy currents induced by such a field are oriented so that the magnetic field which they in turn induce them opposes changes of magnetic flux penetrating the shell. Figures 9; tables 7; references 9.

## Peculiarities of Electrical Properties of Blood Cells and Their Interrelation

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No 10, Oct 92 (manuscript received 27 Sep 91) pp 57-61

[Article by Ye.M. Belyavskiy and L.Ye. Belyavskiy, Kharkov]

[Abstract] Inasmuch as processes and their interrelation in blood cells can be evaluated on the basis of electric field and signals analysis, it has been proposed to use some immunity characteristic of a cell as measure of its ability to restore its intrinsic electric field after an external action (Ye.M. Belyavskiy; ELEKTRICHESTVO, No 5, May 91). As an example is considered the rate of change of voltage  $dv/dt$ , the same rate at identical instants of time within each process cycle indicating a normal cell growth by division. An increasing  $dv/dt$  indicates shortening of the cell multiplication cycle and a decreasing  $dv/dt$  indicates an increasing loss of cells with attendant inhibition of cell growth or even stagnation along with a strong differentiation of cells. The intrinsic field of a cell is responsive to three kinds of signals: 1) signals from command centers in the organism which regulate the cell behavior, 2) signals from the intrinsic fields of other cells, 3) signals from external sources of action. Immunological blood cell analysis can thus be reduced to determination of the temperature distribution in a cell due to a momentary action on its membrane, after the following assumptions have been made: 1) a cell is originally a sphere (certainly valid, inasmuch as processes in a cell do not depend on its shape); 2) an incident electric current pulse instantaneously changes the electric potential at the membrane; 3) an incident electric current pulse induces adequately significant thermal processes in a cell; 4) the intrinsic electric field of a cell is much weaker than the electric field induced by an incoming electric signal; 5) a cell is isolated from other cells and thus not subject to interaction with them. The corresponding equation of heat conduction, in dimensionless variables and parameters, is solved for the appropriate boundary conditions and the condition of symmetry. It is solved by the Tikhonov-Samarskiy method (A.N. Tikhonov and A.A. Samarskiy, 1963), which includes separation of variables and Fourier series expansion. The solution indicates that deformation of a cell by an electric field and the induced thermal field causes changes in the nucleus and a lowering of the immunity, also facilitates transformations and increases the speed of division. The electric charge of a deformed cell is larger and the charge gradient  $dQ/dx$  is larger at the boundaries of such a cell with normal ones. If all proposed hypotheses (Ye.M. Belyavskiy; ELEKTRICHESTVO, No 5, May 91) are correct, then the essential postulates underlying this theory are that: 1) interrelation between cells of different kinds can be established by contact or contactlessly; 2) an isolated cell cannot exist autonomously, even when it contains life-sustaining substances; 3) the behavior of a cell is generally determined by the total content of an incident signal as well as by the response to it. An

immunity evaluation on the basis of this theory indicates a similarity to group properties of cell properties and that the similarity law thus applies to live organisms. It can in this case be defined as the ability of cells to acquire new properties other than their intrinsic ones, upon action by external fields or by signals from other groups of cells. According to this theory, the resultant action of external electric fields or signals has a different effect on different cells and there thus are no two identical cells but only at most similar ones. It follows from the similarity law that there exist two kinds of action on a cell: strong mechanical or electrical impact, or other strong action such as trauma, continuous mild natural action by weak fields or signals. References 6.

### Ways to Reduce Losses of Electric Energy in Electric Power Transmission Lines

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pp 22-24

[Article by G.N. Aleksandrov, doctor of technical sciences, St.Peterburg State Technical University; UDC 621.315.1.017.001.5]

[Abstract] The problem of reducing energy losses in electric power transmission lines is analyzed, considering the three factors which contribute to higher than minimum energy losses. The first factor is a normalized current density higher than the most economical one from the standpoint of total operating and maintenance cost as, for instance, in aluminum conductors: it appears to be less costly to expend more electrical energy on production of aluminum conductors than to waste electrical energy because of their insufficiently large cross-sectional area. The second factor is deviation of actual conditions from optimum conditions ( $\cos\varphi=1$ ) of power transmission and the resulting attendance of inductive currents in the conductors, a deviation which may be acceptable on short 35-220 kV lines but not on lines longer than a few hundred kilometers. That "natural" ( $\cos\varphi=1$ ) power rating of a line can be varied over a wide range by design modification (optimization of the number and the spacing of conductors), but the energy losses in a transmission line of any voltage class are always minimum when  $\cos\varphi=1$ . As a design criterion one may, therefore, consider the optimum ratio of maximum power transmitted to "natural" ( $\cos\varphi=1$ ) power. This approach is demonstrated on a line segment with compensators of excess reactive power at each end. An analysis based on circuit theory and supported by numerical calculations indicates that energy losses in electric power transmission lines can, indeed, be minimized either directly by compensation at a user's facility and by ensuring that the maximum transmitted power remains close to the "natural" ( $\cos\varphi=1$ ) power. The third way of reducing energy losses is changeover to a higher voltage class, especially where long transmission lines are concerned. Figures 1; tables 1; references 4.

### Properties of Oxide Insulation Coatings on Large Conductors Containing A-999 High-Purity Aluminum

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pp 48-50

[Article by Yu.P. Ipatov, candidate of technical sciences, M.V. Trubitsyna, engineer, A.M. Dzhetymov, candidate of technical sciences, S.V. Fedosova, engineer, and N.Ya. Tomenko, engineer, Scientific-Industrial Association "Scientific Research Institute of Cable Industry", Podolsk; UDC 621.315.616.001.5]

[Abstract] An experimental study of oxide insulation coatings on composite conductors containing high-purity A999 aluminum such as used in superconductor and cryoresistor windings was made, of concern being their relevant electrical and mechanical properties after various preliminary treatment of the aluminum surface. Specimens of 1 mm thick and 10 mm wide aluminum busbars were first etched with an aqueous solution of 3 wt.% NaOH + 2.5 wt.% Na<sub>2</sub>CO<sub>3</sub> at 70-80°C for 1 min, after which some were and some were not electrochemically polished with an electrolyte containing 45 wt.% H<sub>3</sub>PO<sub>4</sub> + 30 wt% H<sub>2</sub>SO<sub>4</sub> + 4 wt.% CrO<sub>3</sub> at 85°C. Polishing was done with 25 A/dm<sup>2</sup> and 35 A/dm<sup>2</sup> current density, for 2 min and for 5 min at each current density. On all busbars were then deposited 10-12 µm thick oxide coatings, at an 18-22°C temperature with a 10 wt.% H<sub>2</sub>SO<sub>4</sub> + 1 wt.% Na<sub>2</sub>SO<sub>4</sub> electrolyte and an anode current density of 3 A/dm<sup>2</sup>. They were all subsequently tested for: 1) insulation breakdown voltage and surface roughness after etching and after electropolishing; 2) insulation breakdown voltage after anodization on mandrels 45, 55, 65 mm in diameter and on a flat block; 3) insulation breakdown voltage after bending around contact electrodes 30, 40, 60, 70, 80, 100, 130 mm and without bending on a flat contact electrode. The results reveal a detrimental effect of bending during anodization on the electrical strength and also on the mechanical strength of oxide insulation on aluminum conductors. They also reveal peeling of the insulation film during 1-2 percent deformation already, evidently owing to a pronounced strain anisotropy in A999 aluminum conductors and their fast increasing surface roughness. On the basis of these test data has been designed an apparatus for electrochemical oxide coating deposition on coils of 1 mm thick and up to 15 mm wide A999 aluminum conductors. This apparatus includes a vat, two flexible current leads connected to the coil and to the counter-electrode respectively, a main frame and an auxiliary frame with an array of parallel supporting rods made of a plastic material each, the auxiliary frame being free to move it up and down relative to the main frame. The two frames are mounted so that the rods supporting each are spaced around a circle, the two circles either coinciding with or intersecting each other. Each rod have a slot and can revolve around its axis. A strapped helical coil of 100 turns with a 220 mm inside diameter was placed on the rods and spread so that each turn could, by rotation of

the respective rod, be slipped into the slot and then in this firm position be dipped into the electrolytic vat for anodization at 25-30°C temperature. Two electrolytes were used for oxide coating deposition: 1) the same 10 wt.%  $H_2SO_4$  electrolyte with an anode current density of 2  $A/dm^2$  once for 10 min and once for 60 min; 2) aqueous 6 wt.% HOOC.COOH (oxalic acid) solution. The auxiliary frame was during the deposition process moved either continuously or intermittently 30-50 mm up and down as to ensure periodic exposure of the conductor-rod (metal-plastic) contact spots and a minimum conductor-rod (metal-plastic) contact time (0.3 min and 10 min respectively). The highest breakdown voltage (490 V) was attained for oxide insulation deposited by anodization of aluminum conductors with the oxalic electrolyte directly after etching. Such oxide-insulated coils are fit to be encapsulated with epoxy resins cold-resistant at cryogenic temperatures. Figures 2; tables 4; references 6.

#### Voltage Distribution in Dead-End Insulator String During Repairs

937K0033A Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 3, May-Jun 92  
pp 3-6

[Article by Ye.I. Udod, L.P. Nizhnik, Ukrainian Energy Ministry and Mathematics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 621.311.004.67]

[Abstract] Repair worker movement along the insulator string in a special cab and the possibility of individual insulator shunting make it necessary to assess the possibility of carrying out repairs and their safety and, as a result, evaluate the behavior of the voltage distribution along the insulator string. The voltage distribution analysis of long insulator strings is based on capacitive equivalent circuits whereby the equivalent circuit efficiency is largely determined by the possibility of assigning all capacitance values of this circuit. The computed and experimental values of voltage distribution along a five-link tension insulator string are plotted. An analysis of the findings shows that the insulator characteristic determined by solving the boundary value problem of the equivalent circuit adequately describes the voltage distribution in the tension insulator string and the external field strength. The proposed approach is especially efficient in estimating the voltage redistribution during repairs. Figures 3; references 4.

#### Electromagnetic Field Identification-Based Diagnostics Principles

937K0033B Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 3, May-Jun 92  
pp 6-10

[Article by V.Ya. Lavrov, A.P. Pukhanov, Avionics Institute, St. Petersburg; UDC 537.811:681.518]

[Abstract] The electromagnetic field created by electric and electronic devices is considered as a source of information for solving a number of status monitoring and flaw prediction tasks and two principal problems which must be solved for compiling prediction software are formulated: developing a generalized mathematical model of external fields whose parameters can be identified in actual devices on the basis of an experimental study of relevant electromagnetic field vector components and developing the principles which make it possible to monitor the conditions and predict the flaws in these devices. It is suggested that diagnostics approaches which teach the hardware to learn and identify defects by changes in the field model parameters on the basis of the pattern recognition theory be used and that probabilistic methods be employed in solving the pattern recognition problems. It is expedient to develop the software using a probabilistic generalized mathematical model of external fields and take into account the effect of secondary reflected fields and probing devices in statistical processing of the field data. The above principles are utilized in a diagnostic complex. A variable inductance pickup moved by a PUMA robot controlled by a SFERA-36 microcomputer is utilized while an Iskra 1030-11 microcomputer is used to identify the field and determine the fault type. The complex is tested for forecasting a DR122MV2 induction motor and a series of transformers. Figures 1; references 8.

#### Effect of Wire Glaze-Rime Formation Structure on RF Communication Channel Operation

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ELEKTRODINAMIKA in Russian No 3, May-Jun 92  
pp 18-21

[Article by P.Ya. Golov, S.I. Strilko, Power Grid Design Institute and Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 621.372.2:621.315.175]

[Abstract] Increasing uses of radio-frequency communications over power lines for transmitting data in power grids and the effect of the glaze and rime formations (GIO) on the line attenuation prompted an investigation into the effect of the glaze and rime formation structure on power lines on the operation of RF communication channels. To this end, equivalent circuits of a nonuniform dielectric are considered in two extreme cases: rime is simulated by a parallel plate capacitor with a heterogeneous dielectric consisting of ice needles and flakes oriented along the electric field strength vector; rime consists of ice and air layers normal to the field strength vector. Energy losses as a function of frequency and ice concentration in rime are computed assuming that the ice layers are much thinner than the rime deposits. An analysis of the curves and relationships shows that in GIO with needles and flakes parallel to the field, the dependence of loss on concentration is determined by two competing factors—an increase in the ice concentration leads to an increase in the energy loss medium volume while the field strength in this medium decreases, leading to the frequency dependence of losses for rime and glaze. If the layers are normal to the field, the field strength in the ice does not depend on the

concentration is determined only by the dielectric permeability ratio of the layers. Thus, the character of the dielectric loss dependence on frequency in rime and, consequently, the added attenuation are determined by the rime structure. In the latter case, added attenuation at low frequencies may with rime may exceed that in wires with glaze. This phenomenon became especially important due to the use of the 20-50 kHz band. Figures 2; references 6.

### Geometry Optimization of Screw Toroidal Magnetic Systems

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ELEKTRODINAMIKA in Russian No 3, May-Jun 92  
pp 22-28

[Article by V.V. Bida, Yu.M. Vasetskiy, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 621.3.011]

[Abstract] The need to improve the energy parameters of electrophysical pulsed units employing inductive integrator energy sources focused attention on two ways of lowering the mechanical stress in the magnetic system windings: by developing "powerless" current configurations or zero-moment windings which have no flexural stresses. Methods of decreasing the mechanical stresses in screw windings located on the toroidal surface are investigated and the optimization problem of determining the screw toroidal system geometry is formulated. First, magnetic systems optimized by the maximum electrodynamic force condition in the current circuit are considered, then zero-torque screw solenoids are considered. The computation methods are based on an approximate procedure which makes it possible considerably to shorten the computation volume. The maximum linear force density behavior as a function of the reciprocal aspect ratio, the force distribution along the screw winding for an optimized configuration, and the potential function dependence on the reciprocal aspect ratio are plotted. The potential function extrema are found numerically using a routine developed at the Electrodynamics Institute; an analysis shows that an extremum exists for all geometrical parameters starting with certain minimum values. It is stressed that while systems with minimized electrodynamic forces can be developed and proper selection of the system configuration and axisymmetric external magnetic field can reduce the forces by tenfold, it is impossible to relieve the system completely. The conclusion is drawn that zero-moment toroidal screw systems can be made without an external magnetic field. The need for increasing the necessary system rigidity for zero-torque configurations is stressed. Figures 4; tables 1; references 9.

### Resolution of Compensating Bridge Transducers With Variable Capacitance Pickups

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ELEKTRODINAMIKA in Russian No 3, May-Jun 92  
pp 93-97

[Article by P.I. Borshchev, A.V. Krasilenko, A.I. Novik, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 53.082.722:531.7]

[Abstract] Interest in transducers for nonelectric quantities employing capacitive pickups with a capacitance of fractions of picofarad, particularly compensating bridge transducers (KMIP), prompted a study of the factors which affect the resolution of such transducers used in combination with capacitive pickups and analyses of the limit of compensating bridge transducer resolution in modern low-noise amplifying elements. A compensating bridge transducer block diagram is cited and the purpose and operation of the transducers components are outlined. The compensating bridge transducers are noted for their high linearity, stability of conversion characteristics, and functional flexibility. They are the best known secondary transducers known today. Since the principal factor which limits the compensating bridge transducer resolution is the input stage noise of the imbalance signal amplifier (USN), the quantitative characteristic of the amplifier noise is determined. Analytical correlations are derived which make it possible to calculate the theoretical limit of compensating bridge transducer resolution by a change in the pickup capacitance allowing for the three principal compensating bridge transducer noise components—the thermal resistor noise, gate shot noise, and FET transistor channel noise at the signal amplifier input. The resolution of a compensating bridge transducer prototype developed at the Electrodynamics Institute is  $5 \times 10^{-7}$  pF/Hz $^{1/2}$  which is close to the theoretical value. It is stressed that the absolute resolution can be conveniently used for comparing the response speed of various secondary transducers intended for operation with capacitive pickups. Figures 2; references 7: 6 Russian, 1 Western.

### Dissipative One-Ports and Two-Ports as Measurement Objects

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ELEKTRODINAMIKA in Russian No 3, May-Jun 92  
pp 97-106

[Article by Z.G. Kaganov, Ye.A. Yastrebov, All-Union Scientific Research Institute of Electrical Instruments, St. Petersburg, and All-Union Scientific Research Institute of Oil Field Geophysics, Ufa; UDC 621.317.75(088.8)]

[Abstract] Mathematical modeling of passive two- (DP) and four-terminal networks (ChP) containing dissipative elements having resistance or conduction under the effect of harmonic voltage by complex numbers is considered and a new method of determining the complex parameters of dissipative one- and two-ports which does not call for taking phase measurements is presented. The method is based on connecting the subject of inquiry into the transverse branch of a balanced T-section with an R-Y-R structure where the longitudinal elements are identical linear noninductive resistors whose resistance is known with sufficient precision and which are calibrated. The following secondary parameters of the one-ports are determined: the phase angle, Q-factor, dielectric loss tangent, inductance, and capacitance. The

complex two-port parameters (both balanced and unbalanced) are determined from the primary parameters without phase measurements, thus simplifying many measurement operations. For illustration, voltage measurement by a voltmeter, active power measurement by a voltmeter, and complex parameter measurement of a bilateral two-port are considered in detail. Figures 5; tables 2; references 5.

### Facilities for Live Electric Network Repairs

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*ELEKTRODINAMIKA* in Russian No 3, May-Jun 92  
 pp 107-109

[Article by Ye.I. Udod, Vinnitsa Center for Live Electric Repairs]

[Abstract] The increasing electric power line voltage dictated by the need to increase the power line capacity necessitated the development of systems which make it possible to carry out repairs without deenergizing the wires, i.e., working with live wires so as not to disrupt crucial processes requiring uninterrupted power supply. To this end, the Ukrainian Energy Ministry set up a center for live electric repairs in Vinnitsa (VOP PRN); its personnel is now undergoing comprehensive training; special training curricula which include both theoretical and practical sessions have been developed for each staff category. The principles of live repairs aimed at replacing the tension and support insulator strings of aerial power lines are illustrated graphically. It is noted that computer-aided equipment is used in the training process; in addition to staff training, the VOP PRN enterprise manufactures shielding clothes kits, develops live repair technologies, disseminates its experience and coordinates the activities of other entities. The work of the Rovno pilot enterprise for live repairs (ROP PRN) which has a similar emphasis is outlined. More detailed information is available upon request from VOP PRN at 286021, Vinnitsa, 10th km of Khmelnitskoye chausse. Figures 2.

### New 1,150 kV Autotransformer

937K0033H Kiev TEKHNICHESKAYA  
*ELEKTRODINAMIKA* in Russian No 3, May-Jun 92  
 pp 109-110

[Article by I.Yu. Meleshko, M.O. Raychenko, L.N. Shifrin]

[Abstract] Work on developing transformer equipment for 1,150 kV power lines which has been underway at the All-Ukraine Transformer Engineering Institute (VIT) since the late 1960's is discussed and it is noted that thus far, the power, mass, overall dimensions, and short-circuit (KZ) voltage of the 1,150/500 kV pilot autotransformers (AT) developed in 1970 do not meet industry standards. The difficulties with implementing the next series of autotransformers are outlined and a new AODTsT-667000/1150/550 autotransformer prototype executed according to a classical design is described.

Compared to the earlier versions, the new autotransformer's losses are 14.5 percent lower (240 kW), the mass of the principal materials is lowered by 17 percent (95 t), and the labor outlays are decreased by 25 percent. The new autotransformer specifications are summarized; The following design features are mentioned: the insulation is improved; continuous rather than braided 500 kV winding is used; special structural members are used; a new connection arrangement is developed. The principal designs are protected by patents. Tables 1.

### External Magnetic Field of Harmonic Current Distributed on Circular Ring Surface

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*ELEKTRODINAMIKA* in Russian No 2, Mar-Apr 92  
 pp 20-25

[Article by V.V. Sotnikov, Mari Polytechnic Institute, Yoshkar-Ola; UDC 621.3.045.16(088.8)]

[Abstract] The theoretical and practical importance of the standard current layers located on the coordinate surfaces approximating the windings and other structural members of various electrical engineering devices which draw current for analyzing the external magnetic field (VMP) in them is discussed and expressions which describe the external magnetic field distribution of the surface harmonic current in a circular ring at a random point in the external area of space is derived. The problem under study can be used for analyzing the external magnetic field of complex-shaped windings, e.g., orthogonal coil ends of electric machines. The problem is solved in a spherical system of coordinates and a formula is derived for computing the scalar magnetic potential in this system of coordinates in the form of an expansion into series in terms of spatial spherical harmonics. For illustration, the scalar magnetic potential of a winding consisting of truncated sector-shaped coils symmetrically distributed on a circular ring surface is analyzed and the magnetomotive force (MDS) is expanded into a Fourier series in terms of the  $\varphi$ -coordinate with only odd harmonics. It is shown that the external magnetic field strength can be determined by applying the gradient operation to the scalar potential expression. Figures 2; references 4.

### Diagonal Coefficient Calculation in Electric Field Analyses by Method of First Kind Integral Equations

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*ELEKTRODINAMIKA* in Russian No 2, Mar-Apr 92  
 pp 32-39

[Article by V.A. Brzhezitskiy, Kiev Polytechnic Institute; UDC 537.212:621.31.027.8]

[Abstract] It is noted that computer analyses of potential fields in various practical electrodynamic tasks are more

efficient, informative, and reliable than detailed experimental research. In particular, the method of first-kind integral equations widely used in electric field analyses is examined and a standard problem solved by this method is considered. In so doing, it is assumed that the field pattern is determined by the surface charge density distributions on the electrodes which, in turn, depends on the electrodes' potentials, shape, and dimensions; in other words, the problem is considered in a quasistatic approximation. An expression is derived for determining the diagonal coefficients of first kind integral equations used in solving the above problem. The dependence of the diagonal coefficients' error on  $\cos\beta$  and the application field of the expressions for determining the diagonal coefficients are plotted. The findings complement Kolechitskiy's data and make it possible widely to use the piecewise-linear approximation of the method of first-kind integral equations for practical electric field analyses. The calculations are performed on IBM PC/AT/XT microcomputers. Figures 4; references 11.

#### Inducon-Based Surge Current Generator

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ELEKTRODINAMIKA in Russian No 2, Mar-Apr 92  
pp 40-46

[Article by I.V. Volkov, S.I. Zakrevskiy, I.I. Smolyanskiy, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 621.314.214.332]

[Abstract] A surge current generator developed on the basis of a hybrid multifunction electromagnetic element (often referred to as inducon in Russian sources), which is similar to transformers or choke coils executed with foil windings separated by an insulating film and wound on a common core with a nonmagnetic gap, is considered and its electric diagram is cited. The surge current generator under study utilizes an inducon with two helical foil windings separated by an insulating film. The inducon capacitor charging and discharging processes with a constant electromotive force (EDS) applied at its input are examined assuming that the processes are independent from each other (i.e., each process commences only after the preceding one is completed), thus making it possible to consider the processes separately allowing for the relevant initial conditions. Attention is focused on the capacitor charging between the foil windings. Differential equations of the voltage and current at a certain point with an imperfect magnetic coupling between the foil windings are derived. It is shown that by tapping the windings and changing their arrangement, it is possible to form current pulses with different amplitudes and shapes. The inducon can be used for designing both single pulse and periodic pulse surge current generators. It is noted that there are no principal constraints on the stored energy while the charge and discharge duration can be manipulated within a broad range. Figures 4; references 7.

#### Increasing Phase Shift Measurement Accuracy in Phased Light Range Finder

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ELEKTRODINAMIKA in Russian No 2, Mar-Apr 92  
pp 89-96

[Article by E.D. Volkova, A.G. Kononenko, V.I. Latenko, Yu.A. Masyurenko, A.D. Nizhenskiy, Electrodynamics Institute at the Ukrainian Academy of Sciences, Kiev; UDC 621.317.77]

[Abstract] Extensive uses of phased light range finders (FSD) in various applied geodesic tasks impose increasingly stringent requirements on the accuracy of displacement and distance measurements (a standard deviation (SKO) of no more than 0.1 mm or 0.05-0.07°) with a limited measurement duration of 0.2-2 s and total measurement process automation. It is shown that a relatively high measurement accuracy can be achieved by using a noise immune phase-to-number pulse-duration converter with an additional phase correction channel and that the phase shift measurement accuracy can be further increased by using adaptive error correction algorithms realized on the basis of today's microprocessor devices. A block diagram of a precision microprocessor-based phase meter for a phased light range finder developed at the Electrodynamics Institute at the Ukrainian Academy of Sciences is cited and timing charts of the phase meter synchronization module's (BS) input and output voltages are plotted. The phase shift measurement error components are analyzed and the total measurement error is determined both experimentally and theoretically. The results of metrological certification of the phase meter show that its standard deviation does not exceed 0.03° (or 0.02 mm in linear units) at a single measurement duration of 2 s. Figures 2; references 7.

#### Shielding Clothes Kits for Work on Live Electrical Installations Under 220-750 kV

937K0030E Kiev TEKHNICHESKAYA  
ELEKTRODINAMIKA in Russian No 2, Mar-Apr 92  
p 108

[Article by Ye.I. Udod, Vinnitsa Pilot Enterprise for Work on Live Power Lines]

[Abstract] Shielding clothes kits for protecting maintenance personnel working on live electrical installations from the effect of electric fields are described. The overalls are made from a fabric woven with three threads, two insulating and one conducting. The seams are stitched with conducting tape to stabilize the contact junctions. The shielding gloves and socks are woven with silver-plated and insulating cotton threads. The protective clothes specifications are summarized. Tables 1.

### Combined Discrete Transformations of the Field of Complex Numbers and Their Application in a Signal Correlation Analysis

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*MODELIROVANIYE* in Russian Vol 14 No 5,  
 Sep-Oct 92 pp 20-26

[Article by M. A. Rakov, O. A. Vakulskiy, Ukrainian AS Physics and Mechanics Institute, Lvov; UDC 621.391]

[Abstract] Orthogonal combined discrete signal transforms are developed for a field of complex numbers using a direct and inverse Fourier transform of smaller dimensions. A fast algorithm is examined for performing the constructed transformations for determination of symmetrical correlation functions (SCF), which can be employed as alternate to the functions, traditionally used for correlation analysis, and which are computed by the fast Fourier transform. The fast algorithm for the combined discrete Fourier transform (CDFT) can be realized by fewer computer operations than when using the fast Fourier transform. It also allows for extention of parallel processing. The studies demonstrate a feasibility of constructing highly efficient software and hardware for correlation analysis using the SCF. Possible application of the CDFT include a recursive computation of digital signals operators, determination of the characteristics of two-input linear sections, identification of signals with a changing phase, etc. Figures 4, references 5 Russian.

### Automated Programming System for a Multiprocessor Computer System With a Programmable Architecture

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*MODELIROVANIYE* in Russian Vol 14 No 5,  
 Sep-Oct 92 pp 27-31

[Article by V. F. Guzik, V. Ye. Zolotovskiy, S. M. Gushanskiy, S. V. Lomonosov, Radiotchnical Institute, Taganrog; UDC 681.3.068:681.31.02]

[Abstract] Automatic programming has been developed for a multiprocessor computing system with a programmable architecture intended to solve the digital signal processing problems occurring when processing phased antenna array signals for radar and sonar detection, and also when simulating the behavior of a target or a process in order to predict the effect of changes in the input parameters on the examined system in the areas of nuclear and thermal energetics, thermonuclear controlled synthesis, astrophysics or semiconductor technology. The developed vector-conveyor computing system consists of eight special processors with a systolic structure for solving the digital signal processing problems. The backbone of the special processor is a matrix of systolic cell-processors for a fast Fourier transform. Block diagrams of the special processor and a block diagram of the software are provided. The advantages of the automatic programming system, which are achieved by incorporating a modular translator library for

designing, modifying or debugging the users programs are demonstrated. Figures 3, references 5 Russian.

### Solution of Some Problems With a Personal Computer in a System of Orthogonal Vectors

937K0064C Kiev ELEKTRONNOYE  
*MODELIROVANIYE* in Russian Vol 14 No 5,  
 Sep-Oct 92 pp 31-34

[Article by A. Sh. Chaduneli, Georgian AS Institute of Computer Mathematics, Tbilisi; UDC 621.391]

[Abstract] In order to solve problems by an orthogonal method, a sub-program was developed which allows group operation of multidimensional vectors with a personal computer. The orthogonal method can be used for the solution of different classes of equations, which rationally form systems of linear and non-linear algebraic equations, eigenvalue problems of matrices, ordinary differential equations, partial differential equations, etc. Solutions are provided for some typical problems using the orthogonal method. This includes the Cauchy problem for an ordinary differential equation of the first kind, the boundary value problem for an ordinary differential equation of the second kind, the thermal conductivity problem, and the switching problem in electrical high power motors. A comparative analysis of the solutions by the orthogonal method vs analytical solutions, demonstrates that the orthogonal method is fully satisfactory. References 3 Russian.

### Mathematical Model and Measurements Algorithm in the Localization Problem of a Dipole Source

937K0064D Kiev ELEKTRONNOYE  
*MODELIROVANIYE* in Russian Vol 14 No 5,  
 Sep-Oct 92 pp 78-84

[Article by V. I. Gumenyuk-Sychevskiy, M. A. Primin, I. V. Nedayvoda, Ukrainian AS Cybernetics Institute, Kiev; UDC 537.8:621.391.26]

[Abstract] An analytical method is examined for the solution of inverse magnetostatic dipole source problems. This type of problems include detection of magnetic bodies under water (for example submerged ships), finding metal objects, etc. In practical applications the location of the source and the value of its magnetic moment are determined from the measured data. This problem is called localization of the field source. This paper deals with interpretation of the measurements data which requires development of methods and algorithms for converting the obtained data to a convenient form. An analytic solution of the inverse problem is obtained by applying the eigenvector method. A table lists types of measuring systems which are used for determining the location of the source and its magnetic moment. Location in space of gradiometer sensors is shown in a diagram, which also includes the measured parameters of the magnetic field. A schematic diagram

of a planar gradiometer measuring system is also provided. Probability estimates are made of the eigenvector method's accuracy. Numerical simulation for the solution of the inverse magnetostatic problem is discussed. Figures 5, table 1, references 11: 9 Russian, 2 Western.

### Macrosimulation of the Analog Unit of the ROM Timer

937K0064E Kiev ELEKTRONNOYE  
MODELIROVANIYE in Russian Vol 14 No 5,  
Sep-Oct 92 pp 85-88

[Article by V. F. Bardachenko, Khmelnitskiy Technological Institute, Ye. N. Dzhigun, Ukrainian AS Institute of Modeling Problems in Energetics, Kiev; UDC 681.34]

[Abstract] Equivalent electrical circuits of the analog unit macromodel are developed for a class of timer read only memory (TROM). The particular features of large scale integrated circuit TROM are characterized by a large number of gates, which compose the electronic circuit of the device. It is therefore expedient to use electrical macromodels of the TROM component units for analysis of its static and dynamic characteristics. The dynamic characteristics of TROM were modeled by the equations obtained for the components of the macromodel equivalent circuit. By transforming the system of differential equations to a higher order differential equation, using the developed algebraic relationships, a more accurate solution can be obtained, compared to a regular numerical method's for solution of equations for the analog unit of the TROM macromodel by differential Taylor transform. Figures 4, references 2 Russian.

### Dynamic Programming in Real Time Multiprocessor System Design

937K0042A Moscow AVTOMATIKA I  
TELEMEKHANIKA in Russian No 5, May 92  
pp 147-156

[Article by A.V. Pozharskiy, Scientific Research Institute of Aviation Systems, Moscow; UDC 519.867:681.324]

[Abstract] The problems arising in designing built-in real time systems with loosely coupled parallel multiprocessor configurations due to the low efficiency and insufficient development of existing software tools and application-oriented computer-aided design facilities for real time multiprocessor systems (MSRV) based on statistical relationships and heuristic trial-and-error approximate synthesis methods prompted the development of a model and algorithms for solving the problems of upper layer design. In particular, the issues of distribution, scheduling, and timing are addressed. The proposed model describes a rather broad class of real time systems and ensures a wide selection of real time programming languages for writing modules and simulating performance in quasireal time. To this end, *F*- and *R*-algorithms are considered. The model's shortcomings include constraints on the execution time variability and selective module access. The mathematical description of the algorithms is based on Bellman's dynamic programming premises. For illustration, a sentential description of the *R*-algorithm and its check are presented. Figures 2; references 9: 1 Russian, 8 Western.

### On One Problem of Evasion in Space

937K0042B Moscow AVTOMATIKA I  
TELEMEKHANIKA in Russian No 5, May 92 pp 11-22

[Article by V.S. Zhelezov, M.N. Ivanov, Ye.P. Maslov, E.A. Kurskiy, Control Problems Institute and Region Scientific Production Association, Moscow; UDC 517.977.5]

[Abstract] The problem of two objects—a pursuer *P* and an evader (or target) *E*—moving in space whereby the former is moving at a constant unit velocity over a rectilinear search trajectory and is equipped with a solid detection zone which is an intersection of an elliptical cone and an ellipsoid while the latter is characterized by simple motion at a velocity limited by a certain value is considered. The problem is formulated and solved. The optimum evasion paths are found and the boundary of the area of initial target positions from which evasion is not possible is plotted. For illustration, the problem of evasion path optimization is considered in detail. It is noted that there are no known published sources which solve the problem of evasion trajectory optimization in a three-dimensional space from a moving solid detection zone. Figures 6; references 11: 9 Russian, 2 Western.

**Relationships Among Tensors Under Conjugate Boundary Conditions on a Semi-Transparent Surface**

937K0066A Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1559-1564

[Article by M. L. Pereyaslavets; UDC 538.3]

[Abstract] Approximate boundary conditions on a semi-transparent surface are used for solution of many electrodynamic problems. The surface can consist of a system of parallel wires, a screen, a layer of dielectric material, or a composition of metal and dielectric. The boundary conditions relate the tangential components of electric and magnetic fields, and the tangential derivatives of the field on both sides of the semi-transparent surface. Conditions are examined for two fundamental relationships: 1) the electromagnetic energy conservation law is satisfied, if there are no losses on the semi-transparent surface; 2) the Lorentz lemma is satisfied if the semi-transparent surface consists of reciprocal elements. Relationships among tensors at boundary conditions are obtained here for both cases. Relationships among tensors for some boundary conditions described in literature are also examined. References 4: 3 Russian, 1 Western.

**A Method for Computing the Electromagnetic Wave Diffraction by a Wavy Surface**

937K0066B Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1565-1572

[Article by A. G. Mikheyev, A. S. Shamayev; UDC 517.958:537.874]

[Abstract] An exact mathematical interpretation of a new method (small slopes method) for computing the electromagnetic field reflected by an irregular surface. The accuracy of the method was examined for both the E-polarization and the H-polarization in a wide region of the incident wave parameter values by comparing it to a numerical method. Computations demonstrated that the small slopes method approaches the Kirchhoff's method and the small perturbations method in the regions of their good accuracy and exhibits a better accuracy outside of these regions. In the case of H-polarization, areas with a sharp decrease in accuracy were recorded by all three approximate methods. These regions correspond to the presence of a reflected sliding (grazing) planar wave, which direction makes an acute angle with the wave vector of the incident wave. Regions of particularly strong decrease in accuracy correspond to appearance of two reflected sliding waves. Figures 6, references 7: 6 Russian, 1 Western.

**Modified Multipolar Sources Method in Electromagnetic Wave Diffraction Problems**

937K0066C Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1572-1581

[Article by Yu. A. Yeremin, N. V. Orlov, A. G. Sveshnikov; UDC 537.874.6]

[Abstract] Analysis of electromagnetic wave diffraction by local magneto-dielectric scatterers is required for synthesis of dielectric antenna, analysis of the multi-beam lens system pattern, identification of aerosol ejection into the atmosphere, etc. A modified method of multipolar sources is proposed for solution of boundary value problems of electromagnetic field diffraction, which makes it possible to overcome the shortcomings of other methods and to expand the capacity of the discrete sources method. With this method it is possible to analyze the electromagnetic wave scattering by the conducting and magneto-dielectric bodies of revolution with large wave dimensions. Results are described of the method's application, illustrating the fundamental capacities of the approach to the solution of scattering problems by perfectly conducting and homogeneous dielectric scatterers. Figures 5, references 9 Russian.

**Rectangular Resonator Antenna With a Circular Polarization**

937K0066D Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1586-1591

[Article by B. Z. Katsenelenbaum; UDC 621.372.413.01]

[Abstract] Resonator type antennas consist of open cavities with low transmittance sections in the walls. The natural oscillations of these antennas at long range are in the form of diverging spherical waves. A desired pattern of one of the natural oscillations can be formed by selecting the resonator configuration and distribution of transmittance. Using the transmittance anisotropy of the dense grates of thin metal wires, not only the pattern, but the radiation polarity can be provided as well. An antenna is described which is in the shape of a rectangular parallelepiped, containing two dense gratings of metal wires (strips). Geometrical parameters are determined of the antenna with nearly circular polarization of its radiation. The structure of the natural oscillations of the described resonator antenna with two gratings and the mechanism of forming the circular field polarization of its natural oscillation is illustrated with a model, where the field depends only on z. Figures 2, references 5: 4 Russian, 1 Western

**Efficiency of a Radiometer-Radar Remote Sensing Method for Detecting and Identifying the Inhomogeneities of an Underlying Surface**

937K0066E Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1598-1605

[Article by A. K. Arakelyan; UDC 621.391]

[Abstract] Advantages are examined of a simultaneous application of a radar and radiometer method for detecting inhomogeneities in the natural environment: clouds, volcano, vegetation, ice or snow cover, spills of oil or other surface active substances, internal waves, currents, temperature distributions, foam formation and other man-made or natural occurrences. Different inhomogeneities can produce identical changes of the superhigh-frequency reflecting and radiating characteristics of the background. This can cause additional problems in detecting the inhomogeneities. Because of particular relationships between changes of the superhigh-frequency reflecting and radiating characteristics of the background, exhibited by different inhomogeneities, double information can be obtained about the environment by a combined application of radar and radiometer data, thus the detection characteristics can be improved. It was demonstrated that changes in the signal dispersion of scattered and own radio-thermal radiation of the underlying surface may be used for discriminating the inhomogeneities characteristics with respect to the background. A block diagram of a two channel detector is provided and its operation principle is schematically described. It is shown that the application of the detection method based on a simultaneous application of the results of data on the reflected and own radio-thermal radiation of the substrate provides a preliminary filtering of some inhomogeneities of other types. Figures 5, references 3 Russian.

#### Detection of a Complex Gaussian Signal in the Presence of Interfering Signals in a Teaching Sample

937K0066F Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1605-1608

[Article by D. D. Sadov; UDC 621.396.96]

[Abstract] A complex signal detection problem is examined, and algorithms are developed for its detection. The signal consists of several single signals of unknown locations. It is also being detected in the background of noise of unknown intensity. In addition to the principal sample of size  $n_1$  ( $n_1 > n_c$ , where  $n_c$  is the number of elementary signals), containing a signal and noise or noise alone, there is a teaching sample of size  $n_2$ . Noise dispersion in the teaching sample is the same as in the principal sample. However, a part of the teaching sample is "contaminated" with interfering signals. The examined problem represents another example of a detection problem under conditions of an imperfect teaching sample.

#### Oscillations in the Models of Coupled Neuron Systems

937K0066H Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1609-1615

[Article by E. V. Kalyanov; UDC 612.822.3.087]

[Abstract] Interaction of coupled auto-oscillating structures, which simulate the processes in the thalamus neurons is examined and also the effects of the thalamus neurons auto-oscillations on structures which simulate the oscillating properties of the cerebral cortex. An approach from the position of contemporary achievements in the linear oscillations theory is applied here. It assumes a feasibility of obtaining random solutions in determinate non-linear equations. A numerical analysis is made of different electroencephalogram forming processes by generators simulating pacemakers of the hypothalamus. It is demonstrated that with interaction of the generator's auto-oscillations, changes in the character of integral oscillations occur due to mutual withdrawing and shifting of the partial auto-oscillation frequencies. Figures 2, references 9: 3 Russian, 6 Western.

#### Synthesis of Amplitude and Phase-Shift Keyers of a Reflected Signal Made of Resistive Elements With Lumped Parameters

937K0066I Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1616-1622

[Article by A. A. Golovkov; UDC 537.874.35]

[Abstract] An algorithm is developed for synthesis of control devices at a fixed frequency and for a specified number of frequencies, which contain a four-terminal network of resistive elements. Reflecting type control devices, made of elements with lumped parameters, are widely used at frequencies below 400 mHz. Amplitude and phase manipulators and matching devices are being designed with reactive elements as well as with resistive. Until now, more attention was given in literature to the development of the synthesis theory of the control devices with reactive elements than with the resistive elements. However, the resistive elements in some cases can provide definite advantages over the devices with reactive elements. In this paper limiting characteristics of control devices made with resistive elements are estimated and the feasibility is examined of developing a uniform method for the synthesis of control devices. Three synthesis problems are examined here. A criterion of minimizing the number of parameters which would provide the required characteristics is applied for their solution. Symmetry of the fundamental relationships for resistive and reactive four-terminal networks is demonstrated with respect to the real and imaginary parts of their input immittances, immittances of the switching device, and the non-controlled lumped elements. Figures 4, references 9: 8 Russian, 1 Western.

#### Simulation of Discrete Electron-Wave Interaction in a O-Type TWT With a Non-Uniform Delay System

937K0066J Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian No 9, Sep 92 pp 1654-1658

[Article by A. V. Aksenchik, A.A. Kurayev; UDC 621.385.624]

[Abstract] One-dimensional and two-dimensional non-linear relativistic models of discrete interaction of an electron flux with a field of clearances in a non-uniform O-TWT delay system are described. The model used in this study differs from the previously published in that: 1) An equation is introduced for the n-th harmonic of induced current in the k-th gap, in place of the k-th resonator excitation equation. 2) Focusing uniform, non-uniform and periodic magnetic fields are specified in a tabular form. 3) Large circular particles with a longitudinal and radial deformation are used for the simulation. 4) The effect of the particle's "self-action", i.e. the effect of the total field produced by the moving charges of the particle on the particle's mass center is taken into account. The role of the newly accounted factors, particularly the "self-action" of the particle was demonstrated by testing the model with a different number of large particles. A comparison is made between the results produced by the one-dimensional and two-dimensional models with a different number of layers. Figures 3, references 8 Russian.

**Experimental Study of Acousto-Optical Signal Compressing Filters With a Linear Frequency Modulation, Formed in Combination Computing Synthesizers**

937K0066K Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian No 9, Sep 92 pp 1703-1710

[Article by V. G. Chumak, A. V. Buynichenkov, A. N. Zharov, V. N. Kochemasov; UDC 621.373:621.37/.39:534]

[Abstract] An experimental study was conducted of a stand incorporating a combination computing signal synthesizer (CCSS) with a linear frequency modulation based on a controlled oscillator with a phase-lock loop and fractional frequency division, and an acousto-optic compression filter (AOCF), where the signal weighing is accomplished by employing the physical properties of laser radiation. Several types of acousto-optic compression filters designed for central frequencies of  $f_0 = 130$  MHz and  $f_0 = 75 \dots 78$  MHz were used in the experiment. Two computing synthesizers with similar circuits were used for forming the required linear frequency modulated (LFM) signals. The results of the study demonstrate that the application of laser gaussian weighing produces an increased duration of the compressed LFM, at -3 dB level, by a factor of about 1.5, and that the combined application of the AOCF and CCSS provides a low level of side lobes with the compression coefficient of the LFM signals up to 400. Figures 5, references 10: 9 Russian, 1 Western.

**We are Aiming at European Standards**

937K0065A Moscow VESTNIK SVYAZI in Russian No 7, Jul 92 p 9

[Article by Ye. Konstantinov]

[Abstract] The new Ukrainian Communications Minister, Oleg Petrovich Prozhivalskiy was interviewed. After providing his biographical data, O. P. Prozhevalskiy answered some questions. In his opinion the most urgent task for the Ministry is to intensify training of personnel for working in free market situation. The communications ministry must as soon as possible separate itself from purely managerial functions; each enterprise must solve its own problems. With respect to privatization, the minister believes that for the transition period of 5-6 years, the advantages of the state monopoly must be utilized to accelerate the development of the industry until favorable conditions are established for privatization and competition, which will improve service to the client. The foreign companies investments in the Ukrainian communications industry are encouraged by the administration for long range projects involving large sums and a long development time, while more attention must be given to domestic developments, that correspond to the World standards, and which are already mastered by the domestic industry. For the near future the Ministry will perform the same functions as before. At the present time the ministry will continue to cooperate with the CIS.

**Personal Computers for Construction Management**

937K0065B Moscow VESTNIK SVYAZI in Russian No 7, Jul 92 pp 30-32

[Article by Ye. K. Vasilyev, R. Z. Aliyevskaya, O. B. Myakoshina, S. D. Shamis]

[Abstract] A uniform complex computerized construction management system (CCCMS) "Stroitelstvo" is being developed by the Specialized Design and Engineering Office of Communications Construction Technology. This complex system will make it possible to automate most construction management processes, including production work formulating processes, scheduling, planning, operational record keeping, control and accounting for performed construction or installation works, material and engineering supplies, as well as financial matters, etc. Problems of interfacing the processes at different construction management levels must be solved within the framework of the system. It is envisioned that each construction organization will develop a local network with 2-5 personal computers, and that information exchange between interacting construction organizations will be conducted by communication lines. The system development is to be completed in three stages. At this time the system nucleus has been developed and experimental try-outs were carried out at several construction organizations (stage I). Structure of the system nucleus and its functional capacities is discussed. Works on interfacing the developing "Stroitelstvo" CCCMS with CAD systems of design institutes can and must start in the current year (stage II). Further development of the system will be carried out (stage III) in the near future along with development of individual sub-systems for specific projects. Figures 3.

**How to Construct a Radio Relay Line**

937K0065C Moscow *VESTNIK SVYAZI* in Russian  
No 7, Jul 92 pp 45

[Article by; B. L. Bachurin]

[Abstract] There are some specific features in organization of radio relay lines construction in not easily accessible regions of the country, particularly during the stages of putting the object into operation. The procedure is described for organization of construction of a radio relay line, which was developed by the contractors, foremen, and installation workers at the construction of the Baykal-Amur radio relay line. The installation methods are standard and require no amendments. Five stages are briefly discussed, which include: training of the work crew; delivery of equipment and materials; installation; activation of the station and adjustments; putting the object into operation.

**Strategy for Transition to the Broadband Integrated Service Digital Network in Ukraine**

937K0053A Moscow *ELEKTROSVYAZ* in Russian  
No 8, Aug 92 pp 8-12

[Article by V. M. Dubrovinskiy, V. F. Mikhaylov, V. G. Artemyev; UDC 621.391.28:681.5]

[Abstract] Recommendations are discussed of the International Telegraph and Telephone Consultative Committee (CCITT) on development of a Broadband Integrated Service Digital Network (B.ISDN) in Ukraine. Development of the B.ISDN requires a solution of complex engineering, economic and organizational problems. At the present time, the digital primary network in Ukraine is very weakly developed, and is practically non-existent on mainlines. The strategy is examined for the transition from the existing individual communication network to a B.ISDN, which can be implemented in several stages. The first stage plans include a development of high-quality transport mainline (TM ISDN) for intercity telephone communication, and reconstruction of the local networks, by laying fiber-optical lines and converting from the analog system to a digital. It is envisioned that the capacity of the TM ISDN will be expanded during the second stage, and a further reconstruction and development of local networks will take place based on the non-synchronous transmission mode and fast package commutation concepts. A total transition to the B.ISDN must be completed during the third stage over the entire territory of the Ukraine, including interzonal and local networks. Figures 7, references 6 Russian.

**Implementation of Office and Industrial Communications Network Using DEFINITY System**

937K0053B Moscow *ELEKTROSVYAZ* in Russian  
No 8, Aug 92 pp 17-19

[Article by D. M. Kamenskiy, A. L. Fayner, A. D. Kharkevich; UDC 658.284]

[Abstract] The DEFINITY system for integrated service digital network (ISDN) is examined. The system has been developed by the American Telephone and Telegraph company. It is based on a digital office and industry integrated service, capable of servicing up to 2400 subscribers. The services integrated in the DEFINITY system include: an automatic, operational telephone communication (OTC); an instructions issuing and trouble-shooting system; public address; electronic mail; signalling, etc. The system offers about 300 different services, which can be accessed by dialing codes from regular analog telephones. The DEFINITY system can be effectively employed in offices and industry. The efficiency of capital investments with implementation of the DEFINITY is assured by reduction in cost of linear constructions, due to integration of various services and application of more complex network configurations. Also, because of employment of uniform equipment, provided with powerful facilities for automatic diagnostics, the engineering operation is greatly simplified. Figures 2, references 4: 3 Russian, 1 Western.

**Design of Long-Distance Common Channel Network Using Decomposition Method**

937K0053C Moscow *ELEKTROSVYAZ* in Russian  
No 8, Aug 92 pp 30-32

[Article by I. G. Dorf, M. A. Zharkov, V. A. Naumov, K. Ye. Samuylov; UDC 621.395.31:519.2]

[Abstract] Introduction of electronic and quasi-electronic exchanges in the long distance telephone networks, equipped with signalling devices in a common channel, poses many problems for the designers, specifically a problem of designing an efficient high quality network, adhering to the standards set by the International Telegraph and Telephone Consultative Committee (CCITT). The solution of this problem is time consuming, mainly because of its large dimensions. The long distance telephone network has an hierachic structure and can be divided into clusters. A method is proposed for the common-channel long-distance network design, which consists of breaking it up into sections, and optimizing each section separately. The feasibility of treating a large network as a collection of sections simplifies computations, particularly when new common channel units are added to the existing system. An algorithm was developed for the network design by several stages, and a comparison between designing the network with and without breaking it up into sections demonstrated that only about 5 minutes of computer time was needed for optimizing each of the section by the method of random search, whereas designing the same network without breaking it up into sections required about 20 hours. Figures 1, table 1, references 10: 7 Russian, 3 Western

**Improving the Matching Property of De-Phased Curved Horns in a Specified Frequency Range**

937K0053D Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 92 pp 33-34

[Article by A. A. Timofeyeva, I. A. Kozlovskaya, UDC 621.396.677.73]

[Abstract] De-Phased horn antenna with a curved generating line are widely used with reflector type antennas. These radiators have a good natural matching with the feed-line. But for use with multichannel communication systems, the matching property of the horn must be improved. This can be achieved by providing an opposite phase addition of signals reflected from irregularities. A simple method is described for improving the matching of axisymmetric de-phased horn antenna by determining the optimal length between two irregularities on the generating line. This approach can also be used for improving the matching property of the antenna's waveguides, with gradually varying cross sections between two irregularities. Figures 3, references 5 Russian.

**Design of Non-Reciprocal Waveguide Ferrite Devices in EHF Range**

937K0053E Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 92 pp 34-36

[Article by V. A. Neganov, UDC 621.372.853.2]

[Abstract] The fundamental principles of designing non-reciprocal ferrite devices (NRFD) in extremely high frequency range (EHF), when the height of the ferrite element is smaller than the height of the waveguide are examined. The air gap between the ferrite and the

waveguide wall caused generation of field non-uniformity along the ferrite cylinder axis, which significantly complicated the electrodynamic analysis of the device. Based on electrodynamic modeling and experimental studies, a method was developed for tuning the NRFD, making it possible to find the optimal geometry of the ferrite resonators, and physical parameters of ferrites. The NRFD resonator spectrum was studied without external magnetization. The resonator parameters were determined from the conditions of maximum difference of the adjoining natural oscillations frequency of the non-magnetized ferrite element, and selecting one of them as an operating resonance - the central frequency. Different types of the NRFD were developed whose electrodynamic and geometrical parameters are listed in a table. Figures 5, table 1, references 9 Russian.

**Antenna Switch AK-100 for Transmitting Radio Stations**

937K0053F Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 92 pp 38-39

[Article by V. M. Lozinskiy, UDC 621.396.679.46]

[Abstract] An antenna switch AK-100 was developed by the Samara Scientific Research Institute "Radio" for automatic broadcasting radio stations. These devices, whose sample batch was manufactured by the Samara factory "Promsvyaz", are successfully operating for many years at radio stations POR-1. The AK-100, switches short wave transmitters to symmetrical feeders with a characteristic impedance of 300 Ohms and consists of controlling equipment and a short wave switch. The technical characteristics of the switch and its composition is briefly described. The AK-100 dimensions are not greater than 5220x3550x2250 mm, the weight is not greater than 7500 kg. Figures 2, references 4.

## Present Status of Atomic Power Engineering Worldwide

937K0049A Moscow ELEKTRICHESKIYE STANTSII  
in Russian No 9, Sep 92 pp 43-46

[Article by T.Kh. Margulova, doctor of technical sciences, Moscow Institute of Power Engineering

[Abstract] The trend in development of nuclear power worldwide including the USSR since 1970 is reviewed and analyzed, of concern being the slowdown of the growth rate first after the Three Mile Island accident in 1979 and then again after the Chernobyl accident in 1986. The trend in nuclear power since then till 1990 is compared with the trends in hydroelectric and thermal electric power. Inasmuch as both safety and reliability are of critical importance in the territory of the former USSR too, the IAEA seven-point scale of accident magnitude has been adopted here for guidance in both reporting and assistance. As of 1 January 1992 the total installed nuclear power in the three former republics (Russia, Ukraine, Kazakhstan) is 34,470 MW: 1) 19,520 MW plants with 2-loop VVER water-cooled water-moderated power reactors (8,640 MW in Russia and 10,880 MW in Ukraine), 2) 14,000 MW in plants with 1-loop RMBK high-power pressure-tube reactors (11,000 MW in Russia and 3,000 MW in Ukraine), 3) 950 MW in plants with 3-loop BN fast-neutron reactors (600 MW in Russia and 300 MW in Kazakhstan). With respect to installed nuclear power, the three former republics together thus are only behind the United States and France. With respect to reliability and safety, however, they are behind almost all countries. Further development of nuclear power is dictated by the unreliability of the much larger installed hydroelectric power, full utilization of which depends on the condition of water resources. The installed and thermal power plants will then be made to contribute a decreasing fraction of the total generated electric energy, which will contribute to conservation of fossil fuels and also to a cleaner environment. Figures 2; tables 5.

## Methods of Accounting for Resistance of Electric Arc in Calculation of Short-Circuit Currents in Low-Voltage (up to 1000 V) Networks

937K0049B Moscow ELEKTRICHESKIYE STANTSII  
in Russian No 9, Sep 92 pp 54-62

[Article by Z.V. Kotlyar, engineer, V.M. Zyatin, engineer, and V.I. Polyakov, engineer, Tula Regional Administration of Power System Management and Cherepet state regional electric power plant; UDC 621.316.1.027.4.064.1.025.001.24]

[Abstract] One problem in calculation of short-circuit currents in low-voltage networks is considered, namely taking accurately into account the resistance of the electric arc. All available methods of doing this fall into three categories: 1) assuming the sum of all contact resistances in the power apparatus and arc resistance to be known; 2) performing series of tests with metal-metal

short circuits and metal-to-arc short circuits under various network conditions, then generalizing the data without reference to the characteristics of a nonlinear arc resistance; 3) first determining the mechanism of an open arc, which will indicate how its nonlinear resistance depends on its length, and then including its resistance  $R_a$  as a function of its length  $L_a$  for the calculation of short-circuit currents in specific real networks with resistances and reactances. Calculations made by methods of the first category for two electric power plants in the Tula region (Cherepet and Pervomaysk) have yielded a 10-14 mΩ total contact resistance under a short circuit across motor terminals on an arc resistance from 10 mΩ up to 100 mΩ under a short circuit across 560 kVA transformer bushings, these values differing appreciably from the standard recommended ones. Methods of the second category are altogether not adequate here, being based and general rather than specific data. Methods of the third category require a formula describing the dependence of the arc length  $L_a$  on the arc current  $I_a$  and thus also on the arc voltage  $V_a$ . This approach has been taken using the formula  $R_{arc} = 1050L_a/I_a$  (V.V. Burgsdorf; ELEKTRICHESTVO No 10, 1948) which, although based on study and measurements of arcing in 35-110 kV networks, has been found to be most suitable for arcing in low-voltage networks. Numerical calculations of short-circuit currents on the basis of this formula, supplemented with formulas for arc length and arc resistance as functions of arc voltage, have been made in relative units for 1-phase, 2-phase, and symmetric 3-phase short-circuit faults in low-voltage (below 1000 V) networks. Tables 2.

## Accident-Proneness of Electrical Power Plant Equipment in 1991

937K0049C Moscow ELEKTRICHESKIYE STANTSII  
in Russian No 9, Sep 92 pp 73-78

[Article by N.F. Gorev, candidate of technical sciences, Ministry of Fuels for Power Plants, Russian Federation; UDC 621.311.002.5004.65]

[Abstract] For a reliability and safety analysis of electric power equipment in the Russian Federation, accidents as well as first-degree and second-degree failures which have occurred during the August-December 1990 and whole 1991 period in 105 regional power systems under jurisdiction of the former USSR Ministry of Energy and Electrification are examined as to causes and economic impact, altogether 36,225 second-degree failures, 4,009 first-degree failures, and 87 accidents having occurred in 1991 (94,425, 19,803, and 208 respectively in the entire year 1990). Causes of failures and accidents are classified into those due to and not due to human negligence. The latter are largely attributed to inadequate design procedures, shortages, and environmental factors. It is anticipated that, upon resumption of equipment production to the 1990 and higher levels, electric power systems will still operate under overload conditions and therefore less reliably than they should. This will in turn slow down development of the USSR successor countries for at least

5-7 years, inasmuch as it takes so long to devise and implement measures ensuring resumption of adequately rapid growth in the electric power sector of the national economy. Tables 1.

### High-Frequency Communication Over Aerial Transmission Lines in Electric Power Systems

937K0011A Moscow ELEKTRICHESTVO in Russian  
No 8, Aug 92 (manuscript received 14 Feb 91) pp 7-11

[Article by V.Kh. Ishkin, G.V. Mikutskiy, and Yu.P. Shkarin]

[Abstract] Developments in high-frequency communication over extrahigh-voltage (330-750 kV) and ultrahigh-voltage (above 1000 kV) aerial electric power transmission lines, the growth in number and the total length of such communication channels being projected from the year 1985 to the year 2005. The concept is based on the theory of electromagnetic wave propagation along transmission lines and Maxwell's equations for the electromagnetic field of an aerial transmission line, the telegrapher's equations derived therefrom having been solved by the modal method in accordance with network theory, namely by a linear transformation of  $n$  interdependent voltage or current vectors into  $n$  independent voltage or current vectors in modal coordinates and a subsequent linear inverse transformation from those into phase coordinates. The two key parameters, input impedance and attenuation coefficient, of a channel which consists of homogeneous segments arbitrarily connected at arbitrary points have been calculated in accordance with the general theory of propagation of sinusoidal waves through nonhomogeneous high-voltage channels. Several performance analyses have also covered noise, including corona, and interference. On the basis of experimental as well as theoretical data has been estimated the interference immunity of high-frequency communication channels on high-voltage power lines for various applications such as protective differential-phase relaying (most common method used in Russia), automatic switching, telephone service, remote control and data transmission, or research and development activity. The electrical equipment industry already produces channel apparatus, including BZ wave traps and 19 different FPM coupling filters, designed for optimum performance and tested in accordance with engineering standards. There still remain problems, some of them are associated with physical phenomena and requiring further scientific research: 1) interference caused by short-circuit faults in adjacent phases of a multiconductor line, 2) excessive signal attenuation due to ice accretion on conductors, 3) twisting of conductors under wind loads. Some other problems require further design analysis, one such problem being extension of the frequency range below 36 kHz and above 1 MHz. It is now proposed to use the 12-36 kHz band on long 750-1100 kV power lines and frequency channels above 750 kHz for digital communication systems including fiber-optic ones. Figures 3; references 11.

### Possibilities in Design of Lightning Protection by Electrogeometrical Method

937K0011B Moscow ELEKTRICHESTVO in Russian  
No 8, Aug 92 (manuscript received 20 Apr 92) pp 14-15

[Article by V.P. Larionov, Moscow Institute of Power Engineering]

[Abstract] The electrogeometrical method (SIGRE No 33, 1975) of lightning protection design is based on the theory that a leader channel approaching an arrester causes the electric field intensity at the surface to rise up to a critical level at which a discharge counterchannel begins to develop as a bias for the strike. The key design formula is accordingly that for the shortest distance  $h_{min}$  from the leader head to the target point at the instant of time when a discharge channel begins to form. The more electric charge the leader carries, the larger will this distance be. Inasmuch as a larger charge in the leader produce a larger lightning current, the formula is  $h_{min} = I_{max} + 30(1 - e^{-I_{max}/6.8})$  when distance is measured in meters and current is measured in kiloamperes,  $I_{max}$  denoting here the maximum fundamental current component flowing through the target after a lightning strike has occurred. Design by the electrogeometrical method, which includes estimating the arrester reliability, is demonstrated on two parallel arrester ropes for a radar antenna inside a dielectric radome on an airplane flying at some altitude. The method takes into account the fact that the current during the main discharge decreases as the altitude increases. The calculations are aided by a graph depicting (as straight lines in log-log coordinates) the probabilities that the fundamental component of the lightning current in negative and positive discharges will reach maximum magnitudes from 3 kA up, based on actual current measurements made at the surface of the earth and on hypothetical currents in a 6000 m long lightning channel at 4000 m altitude. The data indicate that a lightning arrester is most reliable on ground and increasingly less so at increasingly higher altitudes. Figures 3; references 4.

### Huber Electromechanical Effect and Development of Its Concept

937K0011C Moscow ELEKTRICHESTVO in Russian  
No 8, Aug 92 (manuscript received 30 Jan 92) pp 24-27

[Article by A.V. Netushil, doctor of technical sciences]

[Abstract] The electromechanical Huber effect, namely development of a mechanical motor torque in wheels running on railroad tracks was first described but not yet fully explained by J. Huber (1959). Neither his subsequently proposed hypothesis of a nonelectrical acting force nor his unconventional physics and correction of Maxwell's field equations by introduction of the "free energy" concept were adequate. An electric motor built on the basis of this effect was, moreover, found to be uneconomical despite its simplicity. Following extensive studies of this effect by K.M. Polivanov and others including this author, I.V. Pentegov has proposed

(Second All-Union Conference on Theoretical Electrical Engineering, Vinnitsa, September 1991) involvement of an electric welding arc and the attendant Dwight force. For an analysis of this mechanism, a cylindrical conductor (wheel) is considered to be rolling on the horizontal surface of a plane conductor (rail) upon passage of an electric current through the contact region. When the wheel is at rest and contact is made along the line of tangency only, then the current density distribution on its surface is symmetric with respect to the center of a circular arc around the contact line. When the wheel is in motion, then an arc develops which closes the circuit between wheel and rail on the trailing side of the now slanting axis of symmetry and the discharge current flowing through that arc causes the current density distribution on the wheel surface to become asymmetric. The current density distribution can, for calculation purposes, be replaced with an equivalent lump current flowing through a weighted average point on the current-carrying rail segment and this point will shift in the trailing direction as the velocity of the wheel increases. The electrodynamic force which repels that current from the rail can then be calculated approximately by considering the interaction of a small conducting hemisphere and a large conducting hemisphere, the Lorentz law pertaining to interaction of a magnetic field and an electric current then being applied to this analog of the Dwight model. Such a calculation has yielded a repulsion force proportional to that current squared and an electromagnetic torque proportional to that force acting on the motor shaft. After having been neglected for about 30 years, the Huber effect has regained respect following discovery of the Searl effect and invention of the Searl motor for "flying dishes" (1989). This new effect is essentially an extension of the Huber effect to a set of magnetized cylinders rolling on magnetic hoops while contact is maintained by the magnetic attraction force. The current necessary for the Huber effect to be operative can be generated by compound longitudinal-transverse magnetization of a roller so that the necessary e.m.f. is induced in the roller-hoop circuit. Figures 7; references 16.

### Stability "in Large Sense" of Pulsed D.C. Voltage Converters With Pulse Duration Modulation

937K0011D Moscow ELEKTRICHESTVO in Russian  
No 8, Aug 92 (manuscript received 2 Dec 91) pp 42-46

[Article by I.Ye. Koroteyev and V.V. Perekrest, Kiev]

[Abstract] The key problem in design of pulsed d.c. voltage converters with pulse duration modulation is considered, namely optimization of the power circuit and the control system so as to ensure stability of the electromagnetic processes in the power circuit. For the purpose of first establishing the conditions for stability, it is proposed to consider stability "in the large" and to associate two persistence intervals with the structure of the power circuit in a way applicable to specific modes of modulation. The increments of the vector of state variables or, more precisely, increments of their norms are then estimated accordingly relative to their magnitudes in the steady state so that conditions for stability not only "in the large" but also "in the small" can be established. This method of stability analysis is applied to RS models of semiconductor devices with linear passive circuit elements, a system of two linear differential matrix equations  $[dX/dt](t) = AX(t) + B(t - \text{time})$  describing electromagnetic processes in the power circuit during those two persistence intervals in absence of fluctuations in the power supply. The parameters here are:  $A_{1,2}$  matrices of power circuit parameters only;  $B_{1,2}$  matrix-columns of input voltages and circuit parameters. This system of equations is transformed into one difference equation in matrix form for the vector of state variables, the power circuit components then being selected so as to produce small output voltage or current fluctuations at the switching frequency within a time shorter than time period corresponding to the elements of the two  $A$ -matrices. Unilateral modulation of the first and second kinds a nonsaturable modulator and also modulation with an integrator and reset are considered, both feedback and closure equations having been derived for each respective control system. This method of stability analysis is applicable to pulsed step-down and step-up d.c. voltage stabilizers, as demonstrated on such stabilizers with voltage feedback only and with modulation of the trailing edge of the control pulse. Quantitative performance and design calculations are made by conventional use of appropriate equivalent circuit diagrams. Figures 4; references 6.

**Prospects for Development of Instruments for Measuring and Controlling Colors**

937K0071A Moscow SVETOTEKHNika in Russian  
No 9, Sep 92 pp 2-3

[Article by V. A. Solovyev; UDC 535.6.002:002.56]

[Abstract] Methods and instruments for measuring color and their application are discussed. It is pointed out that there is a great need for color measurements in industry, medicine or agriculture. Development of separate instrument modules for needs of different branches of industry for solving particular problems is inefficient because it will only expand the nomenclature. It is proposed that the apparatuses for measuring the color characteristics must be designed based on a universal unit principle, providing a structural, informational and metrological compatibility. A review is made of works which are being done now on developing different color measuring devices and a mathematical model for describing the color perception of the human eye. From the point of view of circuit design and construction, the integral colorimeters are most simple. A method is developed for measuring the relative spectral sensitivity of the measuring channel of integral colorimeters. Feasibility of using integral type colorimeters for measuring color characteristics of products in technological processes is very attractive. Remotely controlled colorimeters are needed for studying the natural resources of the Earth by color characteristics. Remote color sensing can be made with photoelectric or visual colorimeters. Mass production of remote controlled colorimeters, including the visual colorimeters, can be organized within a year. References 3 Russian.

**Effect of Illumination on Speed and Safety of Work Performance**

937K0071B Moscow SVETOTEKHNika in Russian  
No 9, Sep 92 pp 4-5

[Article by B. A. Oshchepkov, Sibtsvetmetenergo; UDC 628.977.1:612.014.44]

[Abstract] Complex effects of illumination are examined on speed and safety of work, which are manifested in cases when its level limits the speed of performance due to possibility of injury, damage of equipment and disruption of technological processes. This situation arises, for example, when insufficient illumination restrict confident movements around equipment, proper selection of knobs at the control panel, etc. It is pointed out that this situation limits the performance to a greater extent than other reasons. Graphs are examined showing logarithmic relationship of visual reaction as a function of illumination. The examined features of the effects of illumination on speed and safety of work performance are qualitative and can be used for developing practical measures for increasing the productivity and reducing injuries. Figures 2, references 2 Russian.

**A Simulator of Solar Radiation Using an Incandescent Halogen Lamp**

937K0071C Moscow SVETOTEKHNika in Russian  
No 9, Sep 92 pp 5-7

[Article by T. I. Zhuchkova, A. S. Ivantsev; UDC 621.326:546.13]

[Abstract] A solar light simulator was developed by the All Union Scientific Research Institute for Light Sources. It is based on an incandescent halogen lamp (IHL) and consists of an ellipsoidal reflector with a 70 mm working area. By optimizing the construction of the IHL the following specifications to the IHL were satisfied: the color temperature 5785 K; irradiation of the surface not smaller than 1385 Wt/m<sup>2</sup>; a maximum approximation to a perfect uniformity of the surface irradiation. Modification of the IHL at color temperature of 3200 K for approximating its radiation to a perfectly black body was accomplished by a multi-layer interference coating (MIC) applied on the reflectors. Computations of the MIC were made involving an analysis for finding the spectral characteristics of reflection or transmission, and a synthesis for finding the parameters of layers forming the MIC from spectral characteristics of transmission or reflection. The developed simulator can be successfully used together with complex simulators of solar radiation, providing the required accurate reproduction of irradiation uniformity and non-parallel beams in combination with other light devices. Figures 2, tables 2, references 6 Russian.

**An Optical Wall-Thickness Measuring Device**

937K0071D Moscow SVETOTEKHNika in Russian  
No 9, Sep 92 pp 14-15

[Article by V. S. Shchepin; UDC 621.317]

[Abstract] Modifications, which were made in the optical wall-thickness measuring device model OS-1, and its operational principles are described. The optical wall measuring device is simple to use, and has an acceptable accuracy, but it exhibits a significant shortcoming. When surface of the measured article, is irregular, illumination intensity of the moving end of the light rectangle on the screen is weakened. In addition to the optical devices there are induction type meters. But they also display a significant deficiency, affecting the accuracy of measurements. For their elimination, the graduated screen was replaced by a "photosensitive ruler". The dimensions of the linear photosensitive microcircuit K1200TsL1 with charge coupled devices are 20 x 11 x 3.9 mm. Functions of the microcircuit's leads are listed in a table. This modernization improved the accuracy of measurements by almost a factor of two, expanded the measurement range, and provided for an objective interpretation of the measurements results. Figure 1, table 1, references 3 Russian.

### A Problem Concerning Mercury-Containing Lamps

937K0071E Moscow SVETOTEKHNIKA in Russian No 9, Sep 92 pp 15-16

[Article by G. M. Kozhushko, O. G. Koryagin, V. M. Mikhaylov, V. V. Fedorov; UDC 628.9:658.567.1.004.8]

[Abstract] The results of discussion on the mercury containing lamps conducted by the journal "Svetotekhnika" in 1991 confirmed the validity of the proposed directions for the solution of this ecologically important problem of demercurization, and also confirmed the existence of generally unsatisfactory conditions in this respect in the former USSR. The proposed measures are divided in two groups. One concerns improving the manufacturing technology, which is in the realm of designers and manufacturers, and the other with developing a better demercurization technology, primarily with cardinal acceleration of a practical implementation of the old mercury containing lamps utilization system. Development of effective metal-halogen and sodium-vapor devices and organization of production within 1.2-2 years is a reality, but requires financial resources. Manufacturing of mercury containing luminescent and other lamps will continue, and the problem of their disposal after they become inoperative still remains. Measures are discussed that can be applied for the solution of this problem.

### Application of Contactless Indicators of Electric Signals for Diagnostics of Electronic Equipment

937K0070A Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, Sep 92 pp 4-7

[Article by N. I. Yakovlev; UDC 53.082.74.004:621.3.049.77]

[Abstract] Diagnostic capacity and application of contactless (remote measurement) instruments is discussed. Current measuring devices of this kind made by Hewlett-Packard (HP547A), current probes of the Locator 7203 type made by the company Solartron, and the Flow-Tracer by Membrain are very popular and exhibit good characteristics. Induction sensors are also popular for the remote control of current pulses in digital electronic circuits. However, these instruments provide an acceptable linear resolution (LR) only when measuring currents in the external terminals of microcircuits with a standard 2.5 mm interval between conductors. For diagnostics of microcircuits with a smaller interval, assembly of printed circuits, surface assembly and micromodules, a significant improvement of the LR is required. A small size induction sensor with a ferrite core was designed for operation with a contactless indicator BIT 201, which exhibits a threshold current sensitivity on the order of 0.1 mA, and a LR which makes it possible to distinguish current in conductors with a 0.3 mm interval. The performance characteristic of this instrument is described. This self sufficient universal device can be used with any type of stimulating oscillators and pulsed current sources

with pulse repetition rate in a range between a single pulse and 20 MHz. Performance and composition of a remote indicator of alternating and pulsed voltages BIN is briefly described along with the composition of a combination converter for remote control of voltages and currents. Figures 6, references 11: 7 Russian, 4 Western.

### New General Application Instruments for Electrical Measurements (Universal Measurement Sets UIK-1, UIK-2, UIK-3)

937K0070B Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, Sep 92 pp 7-9

[Article by Z. G. Kaganov; UDC 53.082.74.004:621.3.049.77]

[Abstract] A new method is described for determining complex parameters of two-terminal and four-terminal networks without making phase measurements. A standard voltmeter is used for measuring the active power, capacitance or inductance. The method is based on connecting the examined object to the transverse branch of a symmetric or non-symmetric T-section, whose longitudinal branches are calibrated. The desired parameters can be found after performing simple calculations. The total number of parameters is 19. This method can be employed using three different models of universal measuring sets: UIK-1, UIK-2 and UIK-3 whose composition and performance are described. Figures 1, references 7 Russian.

### Universal Instrument Transducer

937K0070C Moscow PRIBORY I SISTEMY UPRAVLENIYA in Russian No 9, Sep 92 pp 9-11

[Article by Yu. I. Ro; UDC 621.314.621.317.729]

[Abstract] A universal instrument transducer EP 6509 was developed by All Union Scientific Research Institute of Electric Meters, St. Peterburg, together with the Production Association (PA) "Elektropribor", Kiev. This transducer is designed for converting signals generated by thermocouple, thermal resistance transducers and potentiometer sensors to a code signal and standardized direct currents or voltages. Because the transducer is provided with a digital display of the measured parameters in physical units, a coded output with a standard interface, an analog output signal, and a device for indicating deviations from the specified mode of operation, it can be employed with automated control systems of technological processes, as well as at facilities with a low level of automation for providing the required information directly to the operator. A block diagram of the transducer and the fundamental engineering characteristic are provided and its function is described. The universal instrument transducers EP 6509 will be mass produced by the PA "Elektropribor" (Kiev) beginning with the third quarter of 1993. Figure 1, references 7 Russian.

**Modular Input-Output Devices for Design of Information Measuring and Computing Systems**

937K0070D Moscow PRIBORY I SISTEMY

UPRAVLENIYA in Russian No 9, Sep 92 pp 20-23

[Article by A. M. Averbukh, V. A. Komshilova, A. A. Smirnov, V. A. Shcherbakov; UDC 681.327.21/.1.22+681.377.1./2:621.317.799]

[Abstract] Information is provided about new modular input-output devices for construction of information measuring and computing systems. The All Union Scientific Research Institute for Electric Meters continues the development of modular devices for analog and digital input-output, controlled from the trunks of interfaces I41 and IBM PC-Bus. The already existing devices provide for connection to the common trunk of digitally controlled measuring devices, which have no direct access to this trunk, and also provide interfacing of the I41 and the common trunk. The modules are made with printed circuits. The fundamental characteristics of the modular devices for measurement, commutation, conversion, analog and digital input-output, controlled from trunk I41 are listed. Works continue on developing measuring and computing systems for control and management of production processes using crates connected to the PC through the parallel interface I41. This is illustrated by a specific example of the automated work station NIKEL, designed for control and management of technological process in the nickel electrolysis shop at the "Severonikel" plant. Organization of this automated work station is described. Figures 1.

**Silicon Photo-Diodes, Matrices and Registers in the 0.2...1.1  $\mu$ m Wide Spectral Range**

937K0070E Moscow PRIBORY I SISTEMY

UPRAVLENIYA in Russian No 9, Sep 92 pp 27-29

[Article by V. A. Shelenshkevich; UDC 621.383.52:546.28]

[Abstract] A batch of single Photo-diodes was developed by the All Union Scientific Research Institute of Electric Meters. Based on these photo-diodes, matrices and registers were designed with a unique configuration. Unavailability of mass-produced cases, even for single large-size photo-diodes, was the determining factor in directing the efforts of designers on developing different designs, depending on application. Diodes were developed with dimensions of the photosensitive base from 1 x 1 mm to 10 x 10 mm. Different technological operations were employed for increasing the photo-diodes sensitivity, including surface structuring, forming the membrane under the photosensitive area, etc. A design was developed for a 16-terminal metal-ceramic case for a 8-bit photometer based on a 4-bit photo-matrix. Picture of single photo-diodes in a metal-glass case with 2, 6, or 7 terminals, or in a metal-ceramic two-terminal case are shown. Pictures of a 4-bit photo matrix and a 16-bit register are also shown. An elastic compound

based on polyorganosiloxane was used for forming the input "optic window" and sealing the photoelectric transducers.

**Secondary Instrument Transducer for Three-Electrodes Capacitive Sensors**

937K0070F Moscow PRIBORY I SISTEMY

UPRAVLENIYA in Russian No 9, Sep 92 pp 29-31

[Article by V. M. Artemov, A. I. Shulga, E. A. Kudryashov, V. A. Shelenshkevich; UDC 621.314:681.586.772]

[Abstract] A short description is provided of a three-electrode capacitive transducer with a hybrid-film design. In this type sensors, the linear transformation law of the input value changes (transfer capacitance or transfer impedance) is assured by screening and equipotential protection of the electrodes. A block diagram is provided of a secondary instrument transducer consisting of a relaxation oscillator, made with two operational amplifiers and seven resistors. The chip topology was developed to fit the manufacturing technology. Resistors, conductors and bonding pads were produced by sequential operations of sputtering and photolithography. Two design models of the secondary instrument transducer were manufactured: a model without a case, equipped with flexible terminals, and a model in a metal-glass case. Pictures show some capacitive sensors and the secondary instrument transducer. Results of an experimental study of the transducer performance are described. Figures 7, references 4: Russian.

**Measurement and Computation System TsG 7002 for a Wide-Range of Applications**

937K0070G Moscow PRIBORY I SISTEMY

UPRAVLENIYA in Russian No 9, Sep 92 pp 33-34

[Article by A. A. Smirnov, Yu. A. Nekhayev]

[Abstract] The measurement and computation system is intended for designing automatic control systems of technological processes and information and measurement systems for different applications in the national economy. It can measure DC voltages, measure and record voltages of fast-occurring processes, measure time intervals, switch analog signals, and provide for input-output of discrete and initiating signals, control servomechanisms and expand the functional capacities of any digitally controlled measuring devices. The system has an open and flexible architecture. Crate TsG 7002 has 16 spaces for placing modules, an internal interface for the I41 bus and a general-purpose interface bus (GPIB). The system is controlled either from the I41 interface bus, or from the GPIB. General engineering characteristics of the TsG 7002 are provided. The particular composition of the TsG system modules is specified by the users, depending on the type of application. The software

includes a library of the device drivers and a set of demonstration programs of the system operation. Figure 1, table 1.

### Perfecting the Uniform Measurements System in the Country

937K0067A Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 5-6

[Article by N. S. Solomenko; UDC 389.14:53.08]

[Abstract] The problem of perfecting the existing uniform measurements system (UMS) is discussed. It is recommended that in the first place a methodology must be developed for analysis and perfection of a system which would form an objective scientific base for specific studies and developments in any of the CIS countries, and at the same time would provide for coordinated solutions in the field of metrological services. A development plan for such methodology within a framework of fundamental studies on metrology has been submitted by the Council of the USSR Academy of Sciences on Metrological Service and Standardization in 1990. A critical analysis is made in this paper of the existing system and reasons for the need of revising it in compliance with the new social and political situation are discussed. Because of the large scale of works needed for perfecting the system, fundamental research must precede the development of a program of scientific studies. Such research is in progress under auspices of the Russian Academy of Sciences with the participation of leading scientists. These studies will be carried out in 1991-1992. The first stage, dedicated to the UMS analysis is now completed.

### Adaptive and Robust Amplitude Non-Gaussian Noise Suppressors

937K0067B Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 11-15

[Article by A. F. Fomin, O. N. Novoselov; UDC 621.391.827.08]

[Abstract] The contemporary data systems, and communication and control systems operate in a complex and continuously changing noise environment under impact of strong non-gaussian interferences. An effective method of combating these interferences using non-linear noise suppressing devices, whose amplitude characteristics depend on the probability distribution density (PDD) of the noise is discussed. When there are no reliable a priori data on the PDD of noise and changes of their characteristic with time, the non-linear suppressors of non-gaussian noise must be adaptive, robust or adaptive-robust. A situation is examined here where the interference consists of a white noise, and a non-linear converter with a zero time-lag is used as the amplitude noise suppressor. When designing such suppressors, it is necessary to identify or to classify the distribution function or to determine their unknown parameters. In many

previously developed non-parametric and parametric approaches the reproducibility of the PDD form was examined, while the obtained results were not related to their application. In this paper the noise identification is discussed with the objective of increasing the noise suppressing capacity of the employed non-linear real-time processing algorithms, and for providing its simple technical implementation. An analysis and simulation of various models of adaptive-robust zero time-lag non-linear converter's circuits was performed, which confirmed their high efficiency for application in different quasi-optimal identification circuits. Figures 2, tables 3, references 7 Russian.

### Precise Spectral Equipment for Certification of Devices for Measuring the Radiation Flux of Optoelectronic Instruments

937K0067C Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 20-21

[Article by L. S. Lovinskiy, V. I. Sorokin; UDC 536.4:771.534.2:621.393.52]

[Abstract] Studies were conducted by the All Union Scientific Research Institute for Optical and Photometric Measurements on increasing the accuracy of methods and devices for reproducing and transferring the dimensions of the units of a continuous and pulsed radiation of optoelectronic photo-detecting instruments. The results indicate that the error components, which depend on spectral parameters are dominating in the total error. This situation makes mandatory a development of new methods and devices for measuring the spectral density of the radiation flux and the sensitivity of optoelectronic instruments. Methods were developed for computing the spectral components of error in transferring the dimensions of any photometric units depending on the error of spectral measurements, and precision spectral equipment was designed to realize these measurements. This equipment is described here. Computations were made of random and systematic errors, produced by transferring the dimensions of the radiation flux units, due to error in determining the spectral characteristics of the corresponding instruments. The computations demonstrated that the relative value of these errors was by a factor of 3 to 5 smaller than the absolute value of errors in measuring the corresponding spectral characteristics. Figures 2, references 8: 7 Russian, 1 Western.

### The Shift Interferometer as an Element of a Fiber-Optical Sensor of Acoustic Pressure

937K0067E Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 24-26

[Article by O. B. Vitrik, Yu. N. Kulchin, V. F. Obukh, Yu. S. Petrov; UDC 621.373.826:772.99]

[Abstract] Among many types of measuring instruments employing fiber-optic light-guides (FOLG), the most

sensitive are devices whose operation concept is based on recording the changes in the interference signal due to changes in the transfer characteristic of the medium, as well as changes in the FOLG, occurring under the effect of the examined physical process. However, when conducting interferometer measurements at a distance, the employment of long FOLG is limited because of possible random phase changes in the light-waves causing distortions in measurements. A shift interferometer is examined here which eliminates this undesirable effect. In this interferometer the functions of the fiber-optic lines transmitting the radiation are separated from the sensing element which forms the interference signal. This interferometer was developed for measuring the acoustic pressure, where the FOLG are employed for transmitting the light signal. A diagram of the interferometer is provided and the measurement procedures are described. Figures 2, references 6: 5 Russian, 1 Western.

#### Invariant Measurements of Heterogeneities of Magnetic Induction for Increased Information Output of Magnetic Prospecting

937K0067F Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 40-43

[Article by Yu. M. Petukhov, O. P. Khvostov; UDC 621.317.4:550.838]

[Abstract] Invariant characteristics are discussed. The components of the vector of magnetic induction (VMI) and its derivatives which are referred to any system of coordinates whose position does not depend on the angular oscillations of a moving base are invariant to its angular position. A stable angular position of the coordinate system with respect to Earth allows for a full utilization of the invariant characteristics for interpretation of the results of measurements. Invariant measurements can be provided by using any of the standard navigational systems, but a high accuracy of measurements can not be achieved without developing a system with a low level of magnetic interferences. A feasibility is examined for developing a coordinate system which is referred to the magnetic field only. Invariant measurements are discussed in a three-axial coordinate system constructed by using the VMI as one of the reference axis, and the VMI derivative in the direction of the VMI for the second axis, without applying any other than magnetometric information. An analysis was carried out to determine the minimum of characteristics which would contain the total invariant information about the magnetic induction and its first derivatives. This minimum depends on the availability of information on the angular position of the moving base. Invariant measurements with superconducting magnetometric instruments are also discussed. References 2: 1 Russian, 1 Western.

#### Optimal Detection of Magnetic Dipole

937K0067G Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 43-45

[Article by V. A. Yarotskiy; UDC 621.317.42:550.38]

[Abstract] An optimal receiver of a geophysical system for detection and measurements of the parameters of magnetic objects with a dipole structure of the magnetic field was synthesized. In such systems, the useful signal is described by a scalar function of the vector field of the magnetic dipole. Expressions are derived describing the useful static signal in a system with a magnetometer type sensor and in a system with a gradiometer. Computations indicate that the receiver's sensitivity losses due to the signals uncertainty (with respect to a correlation receiver with a fully described signal), in a wide range of the probability values of a false alarm ( $F=10^{-3} \dots 10^{-8}$ ) and the probability of detection ( $D=0.5 \dots 0.999$ ), in systems with a magnetometer are not greater than 2 dB, and in systems with a gradiometer type sensor are 2.2 dB. Figure 1, references 6: 4 Russian, 2 Western.

#### A Set of Standard Instruments for Electromagnetic Field Measurements at Frequencies from 300 Hz to 1000 MHz

937K0067H Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 46-47

[Article by V. A. Tishchenko, L. V. Vasenkov, V. I. Tokatly; UDC 538.12.089.6]

[Abstract] A set of standards was developed by the All Union Scientific Research Institute of Physical-Engineering and Radiotechnical Measurements for certification and metrological studies of instruments for measuring the parameters of electromagnetic field in the 300 Hz to 1000 Hz frequency range. The set includes devices for generating a standard magnetic field in the 300 Hz to 30 MHz frequency range, and a standard electric field in the 300 Hz to 1000 MHz range, comparators of the electric and magnetic fields, instrument's rack, and a set of transportable calibration standards. The structural composition of the set is very flexible and versatile. If required, the functional capacities of the set can be expanded by adding new elements. Independent use of individual structural elements of the set is also possible. For example, a spectrum analyzer can be used together with the standard field generating device for a fast analysis of amplitude-frequency characteristics of antennas. A short characteristic of the standard equipment and its capacity and applications is provided.

#### A Proposal for Legislation "On Metrology" for the Russian Federation

937K0067I Moscow IZMERITELNAYA TEKHNIKA  
in Russian No 10, Oct 92 pp 62-63

[Article by L. K. Isayev]

[Abstract] The proposed legislation on metrology is discussed and its speedy endorsement by the authorities of the Russian Republic is urged. The proposal for legislation "on metrology" along with the proposals for legislation "on standardization" and "on certification" was submitted by the Russian "GOSSTANDARD" to

the Supreme Soviet of the Russian Federation in June 1992 for considerations in Committees. The proposal for the legislation was developed by the All-Union Scientific Research Institute for Metrological Service and consists of a preamble and seven sections containing 28 articles. The general provisions of the proposal are briefly discussed here. The objective of the legislation is to promote the scientific-engineering and economic progress by regulating the application of State Standards and measurements with a certified accuracy using legally approved units, and also to create favorable conditions for development of international relationships. The legislation regulates the relationships of agencies of the State Metrological Service with other legal and physical entities dealing with problems of manufacturing, operation or sales of the measuring devices, etc. The proposed legislation contains several new clauses determined by the particular features of the transition period to the market economy. References 3 Russian.

#### **Metrological Features of the Nondestructive Test Devices**

937K0067J Moscow *IZMERITELNAYA TEKHNIKA*  
in Russian No 10, Oct 92 pp 67

[Article by I. G. Leonov, Z. S. Nikiforova; UDC 389.14:620.179.1]

[Abstract] Methods which are used for inspecting metrological fitness of the nondestructive test devices (NDTD) are discussed. Because these devices exhibit many differences compared to the "classical" instruments, the measurement procedures and methods used with the "classical" instruments can not be directly applied to the NDTD. The NDTD must be calibrated every time before making measurements and the specified sensitivity is valid only for the particular object of measurements. A periodic calibration of the NDTD and determination of its fitness as practiced with the "classical" instruments in many instances is not effective and frequently unacceptable. A "black box" method is described which is used worldwide for complex instruments. With this method, a limited number of normalized critical metrological characteristics is selected for the particular instrument. These characteristics are checked daily or immediately before measurements with a "black box", which is specially made for checking the selected critical characteristics. The principal advantages

of this method is its convenience, efficiency, and a high reliability of control and measurements. This approach to estimating the metrological fitness can also be used for a large nomenclature of the NDTD. Here, the term metrological fitness refers to the engineering condition of a particular NDTD, where several of its normalized metrological characteristics satisfy the conditions and requirements of the problem. References 3 Russian.

#### **Domestic and Foreign Standards for Rejection of Defective Microelectronic Articles**

937K0059A Moscow *STANDARDY I KACHESTVO*  
in Russian No 5, May 92 pp 49-52

[Article by A. V. Bilshteyn, V. N. Bankov, A. P. Nekhay; UDC 621.396.6:621.38.019.3:006.354.054]

[Abstract] Quality control of electronic devices, specifically integrated microcircuits are discussed. The quality control of domestic electronic articles is regulated by the state and industry standards, as well as by the engineering specifications. One of the fundamental and most important indicators of the integrated microcircuits (IMC) quality is its reliability. The particular features of the domestic norms and engineering documentation regulating the principal requirements for the electronic devices existing before 1985 are examined and a comparison is made with the quality control standards and procedures practiced in some foreign countries. It is pointed out that the standardization of technological tests, which makes it possible to reject potentially unreliable IMC is one of the most important tasks for standardization of the IMC manufacturing technology. The quality control tests regulations, comparative to the Western standards, were introduced in 1986 by amendment No 1 in the GOST 18725-83 "Integrated microcircuits. OTU (General Engineering Specifications)" The fundamental principles behind the quality control and test procedures including the alternate methods to electrothermal conditioning for rejection of defective items, as well as economic considerations related to introducing quality control are examined. The 100 percent quality control of microelectronic devices, which is practiced now, is characterized by a continuous testing and fixed procedures, independent of the level and type of defects causing rejections. Figures 2, table 1, references 12: 9 Russian, 3 Western.

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